POWER

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Compulsory Systems of Weights and Measures

EFFORTS are being made to create sentiment in favor of legislation to be introduced in the coming Congress to make the adoption of the metric system of weights and measures in this country compulsory.

It would be a good thing to have one system, for all to write and think and talk in the same units.

It is doubtful if particular systems are enough better for specific purposes to make it worth while to preserve a multiplicity of them.

The metric system has many advantages. If our progenitors had had six or eight fingers on each hand, it would have still more.

Then we should have the simplicity of the metric system combined with the ability to divide down to unity by successive halvings.

The ideal thing would be a system of notation with 16 digits instead of 10, but it would create something of a mix-up to try to put it over.

I do not like that compulsory feature of the proposed legislation.

The metric system is legal in this country now and has been since 1866.

But notwithstanding its more rational basis and greater simplicity, you cannot buy a centigrade thermometer in an ordinary store, and the Weather Bureau gives the daily temperatures in Fahrenheit degrees.

If you asked for ten meters of calico or five kilograms of sugar in any department store, you would have to convert it into yards or pounds before they could fill the order.

A single system of weights and measures is devoutly to be wished, but I doubt if Congress can bring about the unification by compulsory legislation.

People will use what they have been taught and are accustomed to, and any change must be brought about by a long process of education and gradually induced usage, not a police summons.

F. R. Low

Preliminary Findings in Refractory Investigations*

Progress Report on an Investigation of the Conditions Governing the Proper Application of Refractories in Boiler Furnaces*

BY RALPH A. SHERMAN,[1] P. D. HELSER,[2] H. W. BROOKS,[3] AND G. A. BOLE[4]

THE Bureau of Mines has undertaken, in co-operation with eighteen companies operating large central power stations, an investigation to determine what can be done toward the solution of the problems encountered in connection with boiler-furnace refractories.

In consideration of the lack of information on service conditions the following plan of attack on the problem was outlined:

1. Determine as definitely as possible the principal factors governing the failure of refractories in various types of installations.
2. Subject these factors to a detailed experimental analysis.
3. Undertake the formulation of tests that will measure the suitability of the tested material for the given conditions.
4. In case a suitable refractory is not available for a given service, attempt the development of such a refractory.

Approximately six months have been spent in visiting the generating stations of the co-operating companies.

Thirty-four stations have been visited. The furnaces inspected were used under boilers varying in size from 5,000 to 30,000 sq.ft. of heating surface and were fired by underfeed, chain-grate and overfeed stokers, pulverized-coal burners, fuel-oil burners and natural-gas burners. The fuels included high- and low-volatile Eastern bituminous coals, Illinois coals, anthracite, fuel oil, and natural gas. The refractories used in these furnaces represent the principal refractory clay districts and all processes of manufacture. An outline or questionnaire was prepared which included questions on all points bearing on the life of the furnace refractories. It was not anticipated that this preliminary survey would give immediate results which might enable the users to reduce the cost of furnace maintenance; instead, the investigation was merely the first step in the method of attack just outlined.

This progress report presents in Part I a discussion of the observations made during this preliminary survey. In Part II is submitted a discussion of the raw materials for and methods of manufacture of boiler furnace refractories and the known relation of these factors to successful application under various service conditions.

[The abstract of Part II will appear in a later issue.—Editor.]

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*Abstract of report on investigation initiated about a year ago through the activity of C. F. Hirshfeld, Chief, Research Department, Detroit Edison Company.

[1]Assistant Physicist, Pittsburgh Experiment Station, Bureau of Mines.

[2]Ceramic Engineer, Ceramic Experiment Station, Bureau of Mines.

[3]Fuel Engineer, Pittsburgh Experiment Station, Bureau of Mines, during this preliminary investigation. At present, consulting engineer with Fuller-Lehigh Company and advisory engineer to the United States Bureau of Mines.

[4]Superintendent, Ceramic Experiment Station, Bureau of Mines.

Factors Governing the Failure of Boiler Furnace Refractories

BY RALPH A. SHERMAN AND H. W. BROOKS

The factors that affect refractories in a boiler or other furnace may be grouped under three main heads: (1) Physical; (2) chemical; (3) mechanical. These factors, however, are closely related to and interdependent on one another.

The failure of a furnace structure made up of firebricks bonded together with a fireclay or refractory cement may be classified as due to the failure of individual bricks, to the failure of the cement or clay, or to the failure of the structure as a whole. Following is a discussion of the occurrence of the various types of failure as observed in the installations inspected:

Fusion—Refractories, being mixtures rather than chemical compounds, do not have sharply defined melting points. The softening point of a firebrick is that temperature at which the tip of a cone made from the crushed brick touches the base or fuses into a lump under certain definite test conditions. The temperature measured is really the formation temperature of the slag formed by the various constituents of the brick.

It is known that a brick may soften sufficiently to run at a temperature considerably below its softening temperature if heated for a prolonged period. In such an instance the slag has formed at a lower temperature than in the shorter period of heating in the determination of the softening temperature.

The softening points of the firebricks used next to the fire in all furnaces inspected lie above 3,000 deg. F., a temperature rarely attained in a boiler furnace. No instances were seen where fusion of the bricks by temperature alone was the cause of failure of refractories. It will be pointed out later that other factors such as slag attack, vitrification, spalling, deformation under load, and wall shrinkage and cracking, cause failure of firebricks at temperatures below their fusion points. Thus the softening point is not necessarily a true measure of the suitability of a refractory. It is also apparent that refractories with merely higher softening temperatures than those now available are not yet demanded for higher boiler-furnace efficiencies and capacities.

Distortion Under Load—If a load is applied to a brick, it will flow or become deformed at a temperature below its softening temperature. With increasing

loads on the walls of a furnace (which amount to 40 lb. per sq.in. in some recent installations with very high walls) this may be an important factor in failure. The pressures resulting from the lateral expansion of a wall or of a sprung arch may reach this critical point.

It should be borne in mind that there is a rather steep temperature gradient through a brick of which only one end or side is exposed to the fire, and hence the cooler portion of the brick may be able to bear several times the applied load.

It was not apparent that distortion under load was a clearly defined cause of failure in any installation inspected.

Spalling—Breakage of bricks due to stresses set up in the structure by temperature changes is termed spalling. This was apparently a major factor in refractories' failure in oil-fired furnaces, in sprung or suspended arches, in leaning walls, and in a few cases on vertical side walls. There was an evident relation where spalling was a factor, between the extent of the variation of the load on the boiler and the spalling.

Spalling was apparently more severe on surfaces exposed to the maximum amount of radiant heat from the fuel bed such as overhanging walls and arches. Under apparently similar conditions spalling is more severe the larger the refractory shape.

Slag Action—The extent of slag action is dependent on the temperatures attained at the furnace walls, on the chemical and physical characteristics of the coal ash and the refractory, the viscosity of the slag, the porosity of the refractory, and on the composition of the gases at the walls.

All coal ashes contain oxides of iron. Since ferrous oxide forms, with silica, ferrous silicates which fuse at a low temperature, while ferric oxide forms silicates which fuse at a high temperature, the nature of the gases at the walls, reducing or oxidizing, is liable to be an important factor in determining the condition and action of the slag.

When the ash and the firebricks are softened at the furnace temperature, the ash adheres to the surface of the bricks and a combination may take place between the materials, forming compounds of lower melting points.

The slag formed by the interaction of the ash and the bricks will flow down the wall, exposing fresh surface for attack, or adhere to the wall and gradually build out, depending on the slag viscosity under the temperature and gas composition obtaining at the furnace walls.

The ashes of the Pocahontas, New River, Kanawha, Georges Creek, and low-volatile central-Pennsylvania coals and of most of the eastern Kentucky coals being burned in the plants visited have softening temperatures of over 2,400 deg. F. and many of over 2,500 deg. The small sizes of anthracite have a high ash content, but the ash has a high softening temperature. With these coals there was very little slag erosion except when the flame impinged on the wall and produced a sufficiently high temperature to render the slag fluid. Hard slags which build out from the walls are formed with these coals. The damage results to the wall when it becomes necessary to break the slag away, the impact of the fireman's tools loosening the wall and breaking pieces off of the bricks.

Several methods are used to combat this slag adhesion when coal is burned on underfeed stokers. In one case iron ducts are placed along the side walls through which air passes to the tuyeres, thus lowering the temperature at the walls. In others, inclined side-wall tuyeres are installed, which act as grate surface, but on account of the thinner fuel bed the gases arising at the walls are probably more oxidizing than without these tuyeres. Consequently, some of the ash will probably be in the ferric state resulting in higher softening temperatures. The cooling and oxidizing action may be such that the ash will remain unmelted and hard slags will not be formed.

Refractory blocks with holes through which air can flow from a duct in the wall into the furnace act in a similar manner to the inclined-side-wall tuyeres. In addition the refractory is cooled and the attack of the slags on the clay is apparently reduced. A disadvantage of these ventilated clay blocks is the fact that the holes often become slagged over and their purpose defeated.

Slag will not adhere strongly to bricks or blocks made from silicon carbide. Some slags contain, however, certain constituents, probably iron and the alkalies, in such proportions as to attack silicon carbide vigorously. Air-cooled blocks of this material have recently been offered on the market. Air cooling may lessen the erosive action of these slags. The high price of these bricks has acted against their general adoption.

Illinois coals and many coals from the Pittsburgh seam contain ashes having softening temperatures of less than 2,200 deg. F. and of low viscosity at furnace temperatures. These free running slags wash the bricks away rapidly and in furnaces burning these coals slag erosion is ordinarily the principal cause of refractories failure.

These coals are most commonly burned on chain-grate stokers. Air cooling by special perforated blocks or by spacing bricks at the stoker line has been tried with only a moderate degree of success. Water boxes along the side walls and bridge wall reduce the area of slag erosion. These slags generally attack silicon-carbide refractories vigorously.

Pulverized coal may be burned with such low excess air that the resultant furnace temperatures may cause slagging even with coals having ashes of high softening temperatures, particularly if the flames are allowed to strike the walls. The methods used to reduce slag erosion in pulverized-coal furnaces are well known: Cooling the walls by passing secondary air for combustion through channels back of the inner 9-in. firebrick lining to the air ports in the front wall; the introduction of water-tube slag screens in the bottom of the furnace, radiant superheaters, water-cooled walls, fin tubes, or other heat-absorbing surface in the furnace to lower the temperatures resultant while maintaining a low excess of air.

A slag forms on the walls of oil-fired furnaces and gradually collects in the bottom. This slag is black and glassy when cold and quite viscous at furnace temperatures, although it will flow before a firing tool. It did not appear that the temperatures attained on the walls were sufficiently high to fuse the bricks, and since the mineral content of the oil was low, further experimental study is necessary to define the cause of this slagging.

Failure of Support—If other things were equal, a furnace with low walls should use fewer bricks in maintenance than one with high walls. Relieving arches in the side walls which permit the repair of the lower wall without disturbing the upper wall are in general use.

Thermal Expansion and Contraction—Refractory materials have positive coefficients of expansion, and unless proper provision is made by cambers in the wall or by expansion joints, the wall may bulge inward and fall.

Permanent Volume Change—It is pointed out in Part II of this report that up to a certain temperature clays shrink in burning. This is the maturing temperature of the clay, and it should be heated to at least this temperature during the burning of the brick. If the maturing temperature of the clay has not been reached in burning and the firing temperature of the bricks is exceeded in the boiler furnace, as it ordinarily is, then a permanent shrinkage will take place, causing settling and loosening of the structure.

Furnace-Wall Construction—The methods of laying furnace walls vary from alternate header and stretcher courses to one header course with four stretcher courses. A lesser portion of each brick is subjected to high temperatures and the wall is better tied together the greater the ratio of header to stretcher courses, although more joints are exposed to the fire.

One installation was seen where an important factor in the wall failure was the fact that there were four stretcher courses between the header courses. The ends of the header courses had spalled or broken off from some cause and the stretcher courses above had fallen in. This had progressed until 4½ in. of the lining was removed over a large area of the wall.

An excellent method followed by one company was that of placing no stretcher courses to the fire. The wall was tied by courses of 9x13½x2½-in. shapes.

The large furnaces and the air channels back of the furnace lining in pulverized-coal furnaces have introduced some new problems in furnace construction. The furnace lining in an air-cooled pulverized-coal furnace

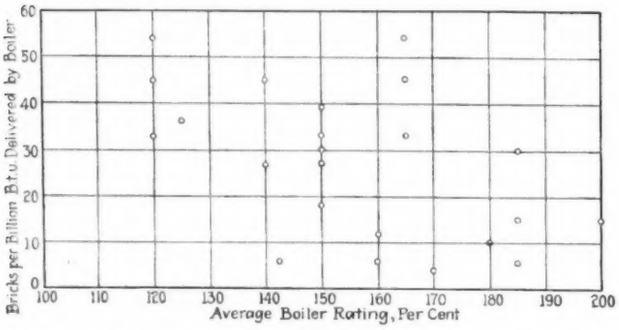


Fig. 1—Variation of number of bricks used with average rating of boiler when burning medium- and low-volatile Eastern bituminous coals

is often built with a camber to provide for expansion and is tied to the outer wall by means of holding tile of special design anchored to beams placed in the outer wall.

Fireclay was found to be the most usual type of material for laying bricks. The tendency is toward the use of a thin batter with dipped and rubbed joints. This practice is limited, however, owing to the non-uniformity of the size and shape of the bricks.

Concerted demand on the part of firebrick users will bring about the production of bricks which are true to shape and size. One Eastern user purchases his bricks on the specification of $\frac{1}{16}$ in. variation in the 2½- and 4½-in. dimensions and $\frac{3}{32}$ in. variation in the 9-in. dimension. Several manufacturers have agreed to meet this specification without an advance in price.

The majority of users have tried one or more of the various high-temperature cements and a few have standardized on one brand. The opinions on the merits of the cements are extremely varied. This is further demonstrated by the statements given in the 1923 Prime

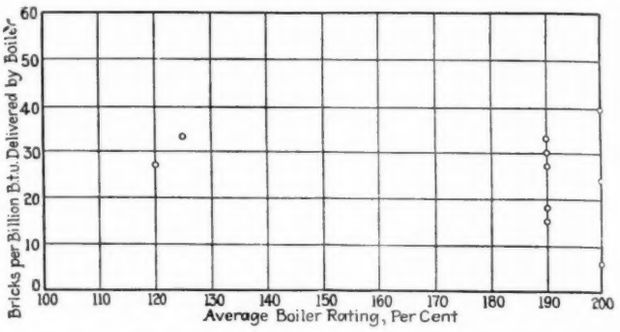


Fig. 2—Variation of number of bricks used with average rating of boiler when burning Illinois coal

Movers Committee Report. Available data did not definitely show decreased cost of maintenance or lessened frequency of repairs owing to the use of high-temperature cements.

Washes for the furnace side walls have been advocated to lessen slag action and infiltration. The reports of the majority of users visited indicated that these washes did not adhere well to the brick surface. There is almost invariably a certain amount of shrinkage which must take place in the firing of the coating which causes it to crack and peel. Some washes do fuse to the surface and form a glaze. In such cases it will generally be found that some material has been added to the refractory to lower its fusion temperature in order that this glazing may take place.

The repair of furnace walls by pounding in or plastering on a plastic material made up from crushed old firebrick and a plastic fireclay or other bording material has lately received considerable attention.

Measure of Refractories Service

The length of life of walls and the frequency of repairs are difficult to obtain and do not lend themselves well to comparison. It was thought that the number of bricks used for repair for a given energy output of the boiler might be a satisfactory measure of refractories service. During the course of the visits to the stations attempts were made to secure such figures, segregating as far as possible the different types of equipment or those operating under different conditions. One figure for an entire station including units of different size or design is of little value for making comparisons. The data obtained are summarized in the table showing the number of bricks replaced per billion B.t.u. of boiler output.[5] Shapes were converted into 9-inch equivalents.

Figs. 1 and 2 show the variations in bricks used with the average boiler rating. There is a tendency

[5] This table and Figs. 1 and 2 were originally prepared to read in bricks per 1,000 boiler-horsepower hours. To accord with *Power's* policy of avoiding the use of boiler horsepower, these have been recomputed in terms of bricks per billion B.t.u. boiler output.

downward in the points on the sheet for the Eastern bituminous coals, indicating that the increase in the number of bricks used is not in the same proportion as the increase in the rating. It is probable that at somewhat higher ratings than shown the curve would turn

AVERAGE LIFE OF BRICK WITH VARIOUS FUELS

Fuel	No. of Bricks per Billion B.t.u. Max.	Min.	Avg.	No. of Groups Averaged
Oil	36	9	24	8
Anthracite	12	3	7.5	2
Medium and low-volatile eastern bituminous	54	4.5	24	28
High-volatile, high-fusion-point ash	18	6	12	5
High-volatile, low-fusion-point ash, Pittsburgh	42	24	33	2
High-volatile, low-fusion-point ash, Illinois	39	6	24	11
Pulverized Pittsburgh coal	..	..	24	1

and rise very rapidly. All but two of the ratings with Illinois coal are so closely grouped as to show no relation.

Samples of coal and bricks have been collected and assembled at Pittsburgh. The usual proximate and ultimate analyses are being run on the coal samples, and in addition complete chemical analyses of the coal ashes are being made.

Prof. C. W. Parmelee, Head of the Department of Ceramic Engineering at the University of Illinois, is directing an investigation on the slagging of Illinois coals which is being conducted by co-operation between the University and the Commonwealth Edison Company of Chicago. Exchange of information has been arranged between the Bureau of Mines and the University on this problem.

No tests will be conducted by the Bureau of Mines on the samples of bricks that have been collected until the service conditions have been more thoroughly investigated.

Second Phase of Problem

The second phase of this problem, which will be initiated on underfeed stoker installations, will include the study of the following: (1) Furnace and wall temperatures. These are to be determined over the full range of the boiler rating and the time-temperature relations are to be determined. (2) The effect of variation in over-fire draft on furnace and wall temperatures. This may include an investigation of the value of steel casing, furnace-wall washes, and outside plastic coatings for the reduction of air infiltration. (3) The effect of water-cooled walls and radiant superheaters on furnace and wall temperatures. (4) Effect of insulation on furnace and wall temperatures. (5) The effect of preheated air on furnace and wall temperatures. (6) The effect of side-wall tuyerés and ventilated blocks on temperatures and gas composition and the formation and composition of slag at the side walls.

Wrenches for taps and dies have two handles so that they may apply a pure twisting effort without any side thrust. A single-handled twisting device such as a pipe wrench produces a side thrust as well as a twist. Where this side thrust is objectionable, it can be reduced by using a wrench with a longer handle. Take the case of a small pipe fitting that requires a twist of 100 ft.-lb. to set up. This can be produced by a pull of 100 lb. at a radius of 1 ft., or by a pull of 50 lb. at 2 ft. The longer handle here reduces the side thrust from 100 lb. to 50 lb.

A thin gasket has less edge surface exposed to the pressure and is therefore less likely to blow out than a thick one.

Storing Coal by Packing It Down

In order to eliminate spontaneous combustion of coal in storage, without the disadvantage of submerged storage, the Philadelphia Electric Co. has devised an effective method of storing. It is necessary to keep a large amount in storage, principally as an insurance against strikes, the company having at present over 225,000 tons of bituminous coal in storage at several points of the system. This coal has been in storage over two years and has given no trouble.

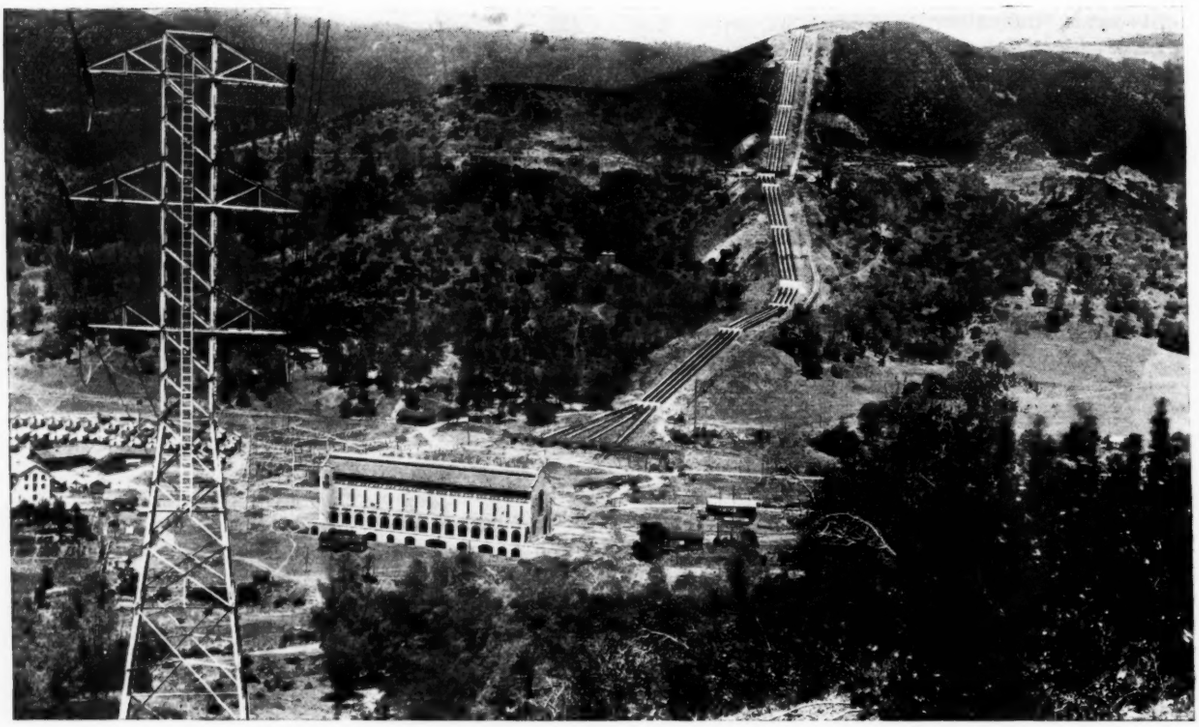
The ground is prepared by covering it with ash or dry earth and then rolling it hard. Over this the base of the pile is started by spreading a layer of coal, approximately two feet deep, over a width of from ninety to one hundred feet, and one thousand or even two thousand feet in length, depending on the length of the property on which the coal is to be stored. This coal is handled by a locomotive crane. A caterpillar tractor weighing approximately two tons then grades this first layer with a drag and after the coal has been leveled a roller is drawn over the pile, thus packing the coal until it weighs approximately 65 lb. per cu.ft. The second layer is then started in precisely the same manner and after it is packed, the third layer, and so on up until the top of the pile is only as wide as the tractor and the roller.

During the time that this pile is being built there is a certain amount of loose coal that will roll down the sides of the pile, and if left there will undoubtedly cause trouble in the form of small surface fires. To prevent this, the operator on the crane trims the sides of the pile at the ground level the width of his bucket after the pile has been completed and in this manner gathers up the loose material and places it on the very top, thus forming the crown of the pile. The pile has now been thoroughly packed from top to bottom. The interesting feature of this is that coal which would weigh 45 and 50 lb. per cu.ft. if piled normally without packing, now weighs 65 lb.

The surface of these piles is so closely packed that they readily shed water, and in all probability the circulation of air is entirely eliminated. Temperatures of this coal have been taken at least every six weeks from the time that the coal was placed in storage, using at each storage plant a portable protectometer.—*From Coal and Ash Handling Report of the N. E. L. A. Prime Movers Committee, Publication No. 25-13.*

The high-temperature distillation of coal, such as takes place in the ordinary byproduct coke oven, breaks down the more delicate distillation into gas and soot. Some of the products thus "degraded" would be more valuable in their original form for motor fuel, etc. Low-temperature distillation, now widely advocated, would undoubtedly conserve our resources. The cost of the processes now available and the existing prices for the products have so far hindered commercial development in this country. In England, where motor fuel is more expensive and the smoke nuisance is acute, there is a widespread agitation in favor of low-temperature carbonization.

One cubic foot of water per second falling through a head of ten feet will develop theoretically 1.134 hp., corresponding to one horsepower for installations with an over-all efficiency of 88 per cent. This relation is useful for rough mental estimates of water powers.



Moccasin power house in center foreground with the four penstocks in the rear

San Francisco's Hetch Hetchy Power and Water Project

THE ultimate project involves building three power houses with a total capacity of 250,000 hp. and the delivering of 400,000,000 gal. of water a day to the City of San Francisco. At present the Moccasin power house has an installed capacity of 100,000 hp. in four units to operate under a net head of 1,250 ft. The four penstocks serving the plant are of plate steel and are nearly a mile long. The power from the plant will bring the City a return of $2,000,000 a year.

FOR the last twenty-five years the problem of obtaining a municipally owned mountain-water supply has been a live issue with the people in San Francisco and vicinity. The first comprehensive report was made on this project in 1902 by C. E. Grunsky, then city engineer. This report recommended the construction of two reservoirs, one the Hetch Hetchy on the upper Tuolumne River, a tributary of the San Joaquin, which flows into San Francisco Bay, and the other the Lake Eleanor on a tributary of the Tuolumne. The water from these reservoirs, which were to be located in the Sierra Nevada Mountains, respectively 3,500 and 4,600 ft. above sea level, was to be brought to the city through a system of tunnels, pipe lines and canals that would have a total length of about 205 miles. This project involved two power plants having a total capacity of 9,000 kw. which was to be used to pump the water over some of the grades.

These plans were somewhat revised, particularly for the mountain region, in 1908 to 1911, by Marsden Mason, at that time city engineer.

The federal government had granted to the City of San Francisco certain rights on federal lands in the Yosemite National Park, essential to building dams to form reservoirs and constructing conduits to bring the water to the city. In 1912 the Secretary of the Interior served an order on the city to show cause why this permit should not be revoked. To oppose this order John R. Freeman, consulting engineer, Providence, R. I., was employed to make another report on the project. This report, along with the reports of City Engineer M. M. O'Shaughnessy and the Board of Army Engineers, resulted in the passing by Congress in 1913 of the Raker Act, granting to the city permission to carry out its project on a greatly enlarged scale as is now being done.

Where the two previous proposals were for a water system of about 60,000,000 gal. per day and generating power for pumping purposes only, the Freeman plan called for an initial daily capacity of 240,000,000 gal., which was to be brought to the city in pressure tunnels and pipe lines, provision being made in the plan to increase the capacity of the water system to 400,000,000 gal. a day when needed. The new plan reduced the

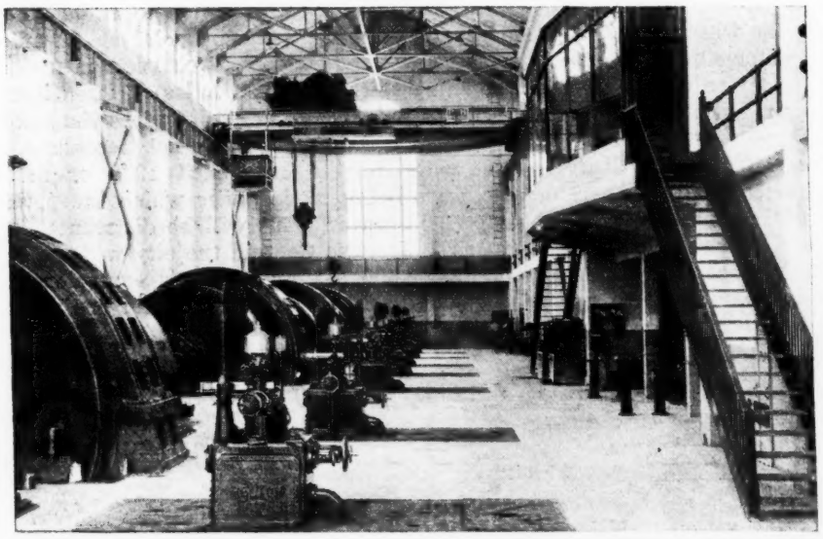


Fig. 1 (Left)—Each of the four 20,000-kva. generators installed is driven by a 25,000 hp. double overhung impulse waterwheel

Fig. 2 (Below)—The O'Shaughnessy Dam, which is of monolithic concrete construction, is 344 ft. high and is so planned that its height can be increased to 430 ft., when it will form a reservoir having a capacity of 120 billion gallons

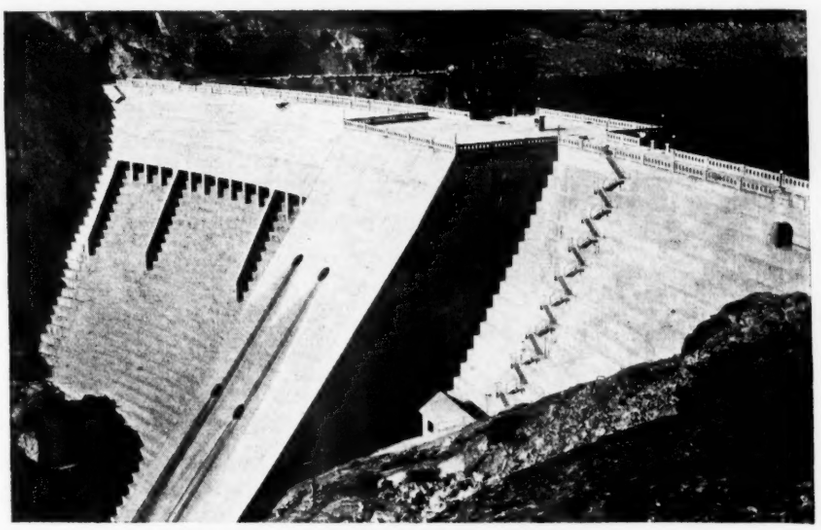
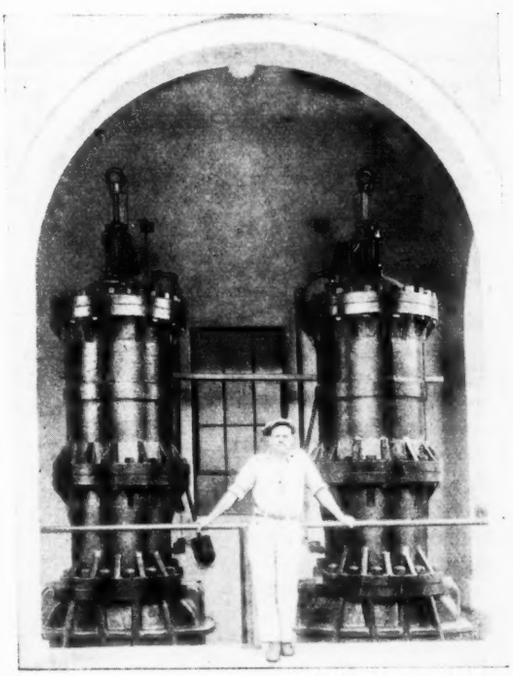
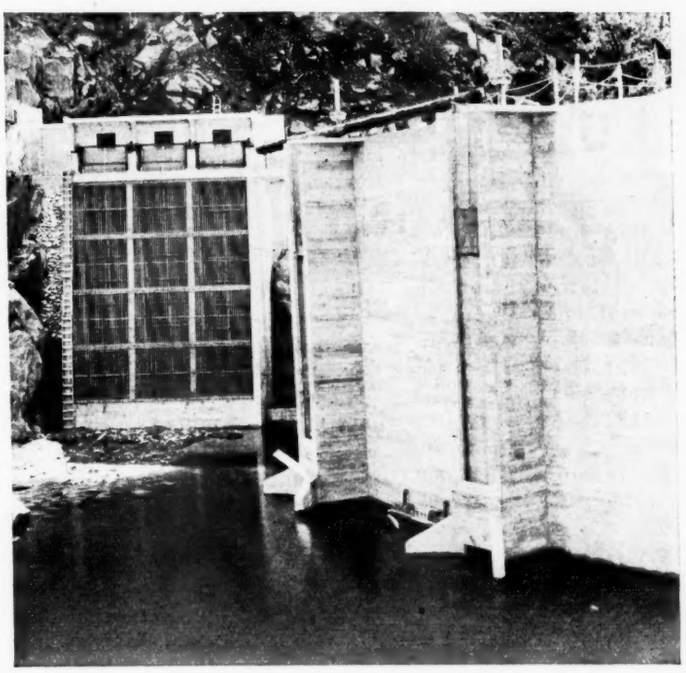


Fig. 3 (Below, left)—Operating cylinders for two 36-in. hydraulically operated penstock gate valves on one of the waterwheels. These valves are on the penstock immediately before entering the power house

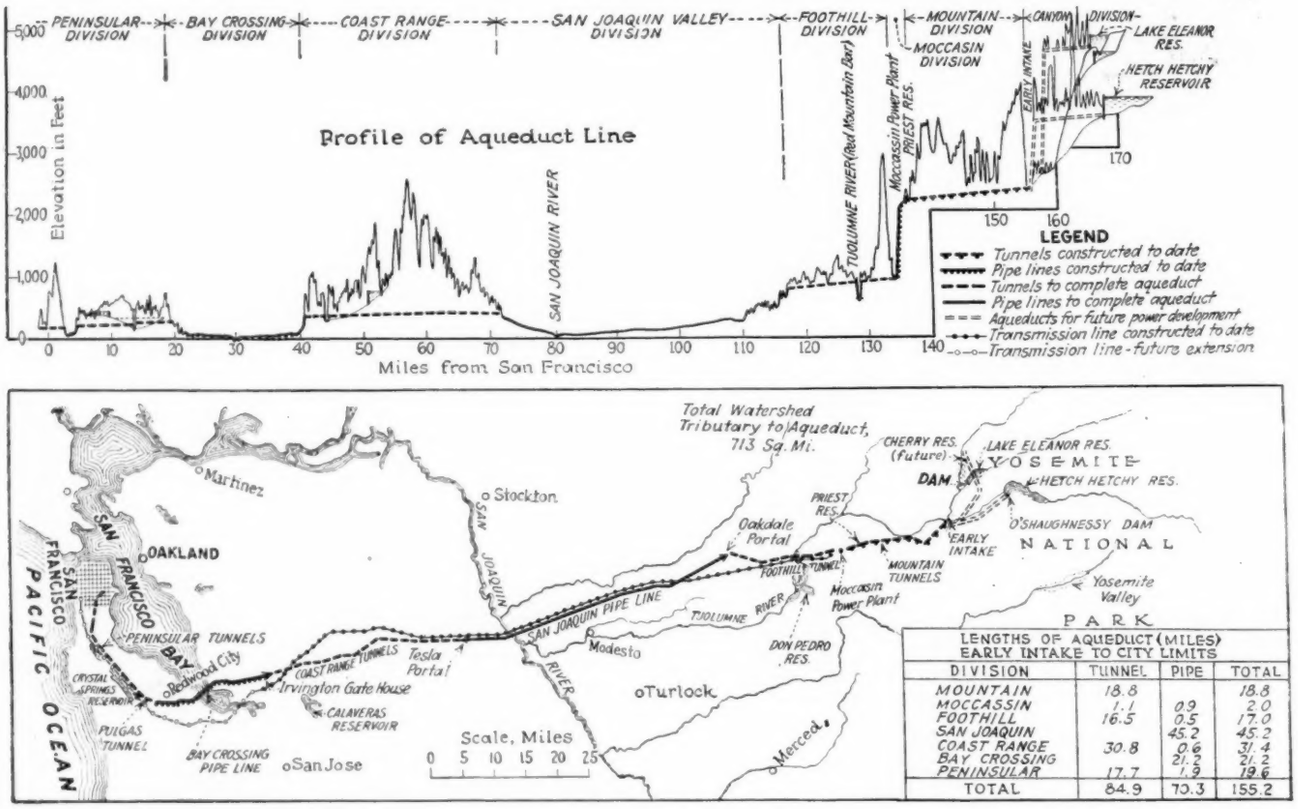
Fig. 4 (Below, right) — Gate tower at Mountain Tunnel intake is equipped with fixed grillage to catch heavy refuse, and wire mesh, manually operated traveling-screens to catch leaves and light refuse





length of the conduit line by about 25 miles. This plan called for the development of 145,000 hp. at three sites, none of which was required for delivering the water to the city but was to be a byproduct of the water supply. The plan as now being carried out with slight modification, is that recommended by Mr. Freeman and indicated in Fig. 5.

The Raker Act carried the provision that 10,000 hp. of hydro-electric power must be developed within three years after completing work adopted for power development and 60,000 hp. within twenty years. Therefore, whether the city wished to or not, it was under legal obligation to generate power, and in recent years this



LENGTHS OF AQUEDUCT (MILES)
EARLY INTAKE TO CITY LIMITS

DIVISION	TUNNEL	PIPE	TOTAL
MOUNTAIN	18.8		18.8
MOCCASSIN	1.1	0.9	2.0
FOOTHILL	16.5	0.5	17.0
SAN JOAQUIN		45.2	45.2
COAST RANGE	30.8	0.6	31.4
BAY CROSSING		21.2	21.2
PENINSULAR	17.7	1.9	19.6
TOTAL	84.9	70.3	155.2

Fig. 5—Plan and profile of the Hetch Hetchy water and power project

part of the development has to a large degree, in the minds of those not familiar with the project, overshadowed the primary purpose; namely, a municipally owned water supply.

The first construction work was started by the city on this project in 1914 on the Hetch Hetchy Railroad and other preliminary work. The concrete-arch dam to form Lake Eleanor reservoir was built in 1917 and 1918. During the war the work was slowed down and with the increased costs of labor and materials it was decided that the Moccasin power project should be completed at an early date to obtain a revenue to help pay the interest on the $45,000,000 bond issue. This is a second reason why the power end of the project has become such a prominent one.

The parts of the work completed or nearing completion are the O'Shaughnessy Dam, which forms the Hetch Hetchy reservoir; the Eleanor Dam, forming Lake Eleanor reservoir; the tunnel leading the water from Early Intake on the Tuolumne River to the Moccasin power plant, a distance of about twenty miles; the Priest Dam, forming the forebay reservoir; the Moccasin power house, the pipe line near and under San Francisco Bay and the transmission line 99 miles long from the power house to a substation near San Francisco. This leaves about 60 miles of tunnel and about 45 miles of pipe line to be built before the water can be brought into the city. It is not necessary to deliver this water to the city until 1930 or 1932. Arrangements are being made under which the power from the Moccasin power plant will be distributed by the Pacific Gas & Electric Co. and the city will receive a return of $2,000,000 a year. This is equivalent to 5 per cent on the total investment in the project to date with the exception of that in the bay-crossing pipe line, on which the interest is paid by the Spring Valley Water Co., which supplies the city with water at present.

Watersheds and Reservoirs

Hetch Hetchy reservoir stores 206,000 acre-feet and the dam will be raised in the future to store 348,000 acre-feet. The O'Shaughnessy dam, Fig. 2, which forms this reservoir, is of monolithic concrete construction, at present 344 ft. high from its foundation on solid rock to its crest. The construction has been so planned that at some future date the height can be increased to 430 ft. Lake Eleanor reservoir has a capacity of 28,000 acre-feet, which at some future date will be increased to 218,000 by the construction of a rock-fill dam 235 ft. high in front of the present multiple-arch dam, which is 75 ft. high and will form the upstream toe of the future dam. The water now released from Hetch Hetchy reservoir flows down the canyon of the Tuolumne River to Early Intake, the

beginning of the 156-mile aqueduct to San Francisco. It is planned in the future to build a 12-mile tunnel from Hetch Hetchy to Early Intake for a 60,000-hp. plant whose tailrace will discharge into the aqueduct intake. Future plans involve the construction of an 8½-mile aqueduct from Lake Eleanor to a power site at North Mountain, where 40,000 hp. will be developed and the water discharged into the Toulumne River about one mile above the present aqueduct intake. The general arrangement can be seen on the profile, Fig. 5.

At Early Intake is the diversion dam and the aqueduct intake tower with gates regulating the flow of water for San Francisco's use. Waters to supply the Turlock and Modesto Irrigation Districts pass over the spillway in the dam to flow down the Tuolumne River about 40 miles to Don Pedro Reservoir (see plan Fig. 5).

The gate tower at the tunnel intake, Fig. 4, is equipped with fixed grillage to catch heavy refuse, and wire-mesh manually operated traveling screens to catch leaves and light refuse. Sand chambers in front of the screens discharge through the dam.

The Mountain Division tunnels extend 18.8 miles from Early Intake to Priest Reservoir. About 14.3 miles of this tunnel is lined with concrete having a minimum thickness of 6 in. The tunnel with a grade of about 8 ft. per mile has a capacity of 620 sec.-ft., or about 400,000,000 gal. per 24 hours. At the tunnel portal water enters Priest Reservoir, the forebay for Moccasin power plant. This forebay contains over two days' flow of the tunnel.

Moccasin Power Tunnel

Water released from the reservoir to the power house enters Moccasin power tunnel through a concrete inlet control tower. Regulation of water is effected by six electrically operated sluice gates. Manual operation is also possible, and steel shutters are provided for isolating any set of four gates for repairs if necessary. Fixed screens with manually operated cleaner prevent fine trash from entering the tunnel. The power tunnel extends 5,370 ft. to a surge shaft 40 ft. in diameter, from the farther face of which branch the three penstock pipes embedded in concrete in tunnels 535 ft. long.

The three penstocks, each of which is 5,369 ft. long, begin at the edge of the surge shaft, as the frustum of a cone with large diameter of 12 ft. 4 in. The smaller end connects to a 104-in. diameter butterfly valve about 50 ft. from the tunnel portal. One of the pipes is capped for future extension when two more generators have been installed in the power house. The butterfly valves are motor operated and arranged for closing by remote control from the power house. As a matter of safety opening cannot be done by remote control. Each pipe is fitted with two sets of four 8-in. air valves.

Beyond the butterfly valves the penstocks reduce to 98 in. At a slope distance of 2,111 ft. from the tunnel portal the pipes branch, each into two of 66-in. diameter, with longitudinal seams hammer forge welded and with "bumped" joints of enlarged section to obviate any obstruction to stream flow by rivet heads. The welded pipes range in diameter from 66 to 54 in. and in thickness from $\frac{7}{16}$ to $1\frac{5}{16}$ in. Immediately before entering the power house each of the four 54-in. diameter pipes branches into two of 36-in. diameter, in which are set in the power-house arcade, hydraulically operated, extra-heavy 36-in. valves, Fig. 3.

The tunnel and penstocks between Priest Reservoir and the power house have been so designed as to provide an effective hydrostatic head on the nozzles of the waterwheels of 1,250 ft. This pressure is greater than has been used on Francis-type waterwheels, therefore the impulse type was adopted. Bids were invited for waterwheels having speeds of 225, 240 and 257 r.p.m., and for direct-connected generators of the same speeds. It was found that units having a speed of 257 r.p.m. would be cheaper and have as good efficiency as those operating at the slower speeds. This speed was therefore selected, requiring 28-pole generators.

The waterwheel contracts were awarded to the Pelton Water Wheel Co. These units are of the double-overhung type having a full-load rating of 25,000 hp. with a maximum rating of 27,500 hp. each. The generators were supplied by the General Electric Co. and are rated at 20,000 kva. at 11,000 volts, three-phase, sixty-cycle.

Four complete units were purchased, making an initial installation of 100,000 hp., or 80,000 kva. Operated on 100 per cent load factor, three of these units would utilize all the 620 cu.ft.-sec. of water which is available. The fourth unit permits operating at 75 per cent load factor or may be used as a spare unit should the plant be operated at a higher load factor. On account of the characteristics of the plants to be installed higher up on the Tuolumne River, it will later be required to operate Moccasin plant at a load factor of 50 per cent, making it necessary to install two additional units when the other plants are constructed. Provisions have been made in the Moccasin plant to install these two units.

Speed Regulation by Governors

With a generator flywheel effect of 3,000,000 WR^2, the rise in speed for rejection of a load of 25,000 hp. will be 14½ per cent with the governor adjusted so as to give a full stroke in two seconds. If this time is extended so that the governor does not move a full stroke in less than three seconds, the speed rise will be 21½ per cent. Load may be taken on one unit at the rate of 2,000 hp. per sec. without causing appreciable drop in speed or injurious change in pressure of the water in the penstocks and tunnel.

A direct-connected 250-volt exciter is overhung beyond one of the waterwheels on each unit. These exciters have a capacity of 140 kw., and being direct connected to the main waterwheel, obviate the necessity for a separate waterwheel-driven exciter. In order to take care of emergency conditions a motor-generator exciter has been installed. This has sufficient capacity to supply excitation current for any two generators.

Outside of the power house, along the east side, is a structural-steel busbar support. Within this structure will be set the twelve 6,667-kva. Westinghouse transformers stepping the 11,000-volt current as generated up to either 115,000 or 154,000 volts for transmission to the substation 99 miles distant. These transformers are of the water-cooled, oil-insulated type. One spare is provided, which may be moved into the place of any transformer that becomes disabled.

Power wishes to acknowledge assistance rendered in the preparation of this article by Chief Engineer M. M. O'Shaughnessy and Electrical Engineer Paul Ost, both of the City of San Francisco.

Direct-Current Motors Fail To Start—Open Circuits

METHODS of determing from the symptoms of the trouble where the probable location of the fault is and how to locate the defect by test.

By B. A. BRIGGS

ASSUME a condition where the motor was operating satisfactorily when shut down but when an attempt was made to start, it failed to respond. Further, assume that the motor is compound-wound and connected to a manual-type starting box as in Fig. 1, and that when the arm of the starting box was brought up on the first contact, the motor having failed to start, the arm was allowed to fall back to the off position without a spark occurring when the arm broke contact with the first point on the starter.

As pointed out in the article, "Direct-Current Motors Fail to Start—General Considerations," May 26 issue, what happens when the arm breaks contacts with the first point on the starter tells a lot about where the trouble may be. Where there is no spark when the arm breaks contact with the first point of the starter, there are other conclusions that may be arrived at other than "the circuit is not complete to the motor." First of all, the most likely place for this circuit to be interrupted is at the fuses and switch, and it is here that the trouble should be looked for first.

Diagnosis of the Trouble

It is very improbable that the trouble is in the motor, since to completely interrupt the circuit through the motor, two circuits, the field and armature, must be opened. This would be a very unlikely occurrence, except for a series motor, which has only one circuit. If the armature circuit were open at any point and the field closed, a spark would have been obtained when the starting-box arm broke contact with the first point. This would also be the case if the armature circuit were

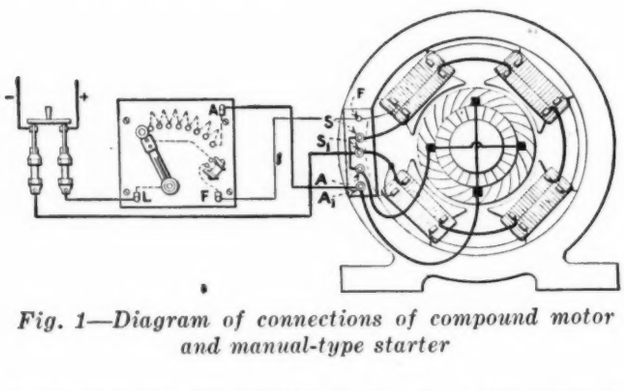
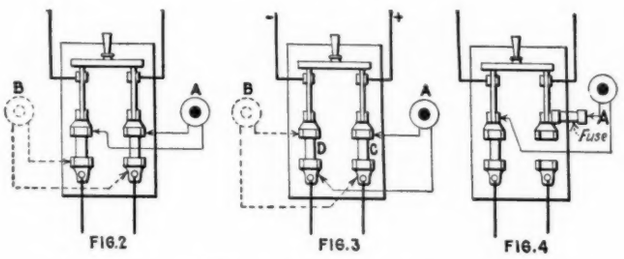


Fig. 1—Diagram of connections of compound motor and manual-type starter

closed and the shunt-field closed. Since the motor is compound wound, it would very likely start, unless heavily loaded, even if the shunt-field circuit were open.

Where the indication of a complete interruption of the circuit to the motor is obtained, there are two other places outside of the line where it would be most likely to happen. One of these would be between the fuse and the starting box. There may be an open in the wire, or the arm on the starter may not touch the contacts, owing to the contact shoe on the arm being worn loose or broken off.

The only other place where the breaking of one wire could completely interrupt the motor's circuit is the wire that runs from the left-hand fuse to terminal S_1 on the motor. Both the armature and field current pass through this wire when the motor is in operation.



Figs. 2 to 4—Method of testing fuses with a lamp

From the foregoing the conclusion may be drawn that the most likely place for the trouble to occur is at the fuses or switch or farther back on the circuit. The other two places where the trouble would be most likely to happen is between the right-hand fuse and the starting box and the left-hand fuse and the motor. From these deductions one can start in an intelligent way to locate the fault. Right off, when starting to look for the trouble, see that the shoe of the contact arm on the starter is in good condition and making good contact. If this is found O. K., then attention should be given to the fuses. In all cases when the circuit through a motor shows dead, the power source should be tested, as it is of little use looking for the trouble until it is certain that power is on the line.

Method of Testing the Fuses

The fuses are tested with a lamp as in Fig. 2—first, as indicated at *A* and then as at *B*. If the lamp does not light when connected across the switch as at *A*, it is an indication that the line is open somewhere back of the switch, in which case the condition of the line connections to the switch should be determined and a test made right down where the wires enter the lugs to see if they are alive. Sometimes the wires are poorly soldered in the lugs and become corroded to such an extent as to open the circuit. If the ends of the line wires are found to be dead, then it is a case of going back to the next set of connections on the line and test at this point with the lamp. If the line is alive here, it would indicate that a wire is broken somewhere between this location and the switch at the motor. However, conclusions should not be arrived at before making sure that one is correct, or considerable delay may be incurred in arriving at the cause of the trouble.

Assume that when the lamp is connected to the switch as at *A*, Fig. 2, it lights, but when connected to the bottom of the switch as at *B*, it does not light. This would indicate that there was an open in one of the fuses, although this is not necessarily so since some of the connections may be loose. To find out where the open circuit is, first connect the test lamp as at *A*, Fig. 3, and then as at *B*.

Consider a case where the lamp lights when connected at *A*, but does not when connected as at *B*. This would indicate that fuse *C* is open, because the circuit is from the + side of the line through fuse *C*, lamp *B* and back to the — side of the line. Since the lamp does not light, it can be assumed that the fuse is defective.

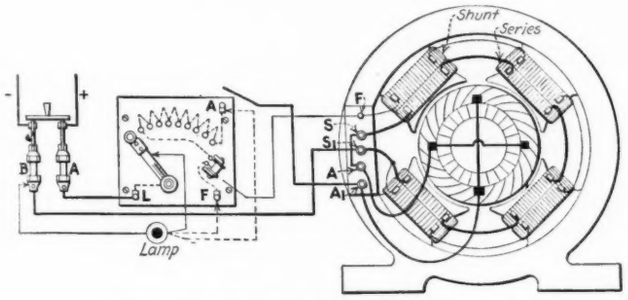


Fig. 5—Testing starting-box circuits

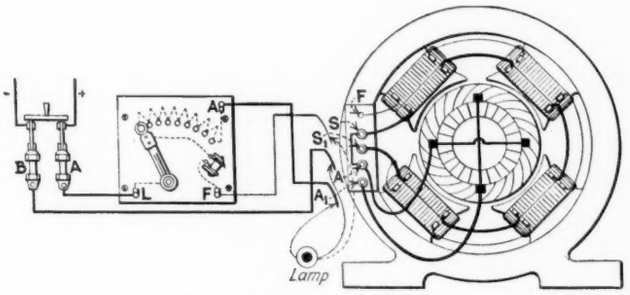


Fig. 7—Testing continuity of motor wiring

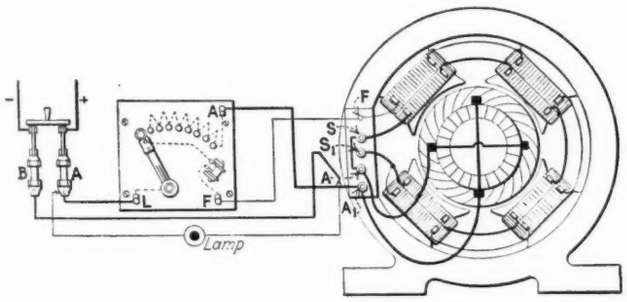


Fig. 6—Testing continuity of line wire

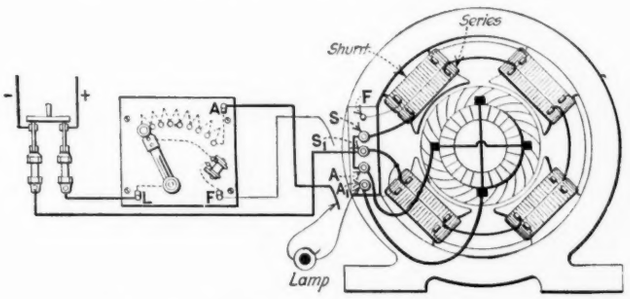


Fig. 8—Testing circuits through motor

To check this the fuse can be removed and tested as indicated in Fig. 4, in which case the lamp will not light if the fuse is open. Of course this decision should be checked by connecting terminal *A* of the lamp to the switch blade to make sure that the lamp will light if the fuse is complete.

Consider a condition where lamp *B*, Fig. 2, lighted when connected to the bottom of the fuses, which would indicate that power was getting to the starting box and motor and the open must be in some part of the circuits. The first place to look for the trouble is to see that the wires are making good connection with the bottom contacts of the fuses. If these are found all right, then test with a lamp as in Fig. 5. If the lamp lights when connected to the arm on the starting box, it shows that the circuit is complete to this point. This test should be made with the arm in the off position so that only the wire between fuse *A* and the starting box will be in circuit. If this part of the circuit is found complete, disconnect the wires from terminals *A* and *F* on the starting box, move the arm on the first contact and then touch one lead of the lamp on terminal *F* and then on *A*, as indicated in dotted lines. Assume that a light is obtained on both of the terminals of the starting box in Fig. 5. This would indicate that the trouble is not in the starting box and that probably the defect is in the wire leading from the S_1 terminal of the motor to fuse *B*. If the switch and starting box are near the motor, then disconnect the line wire from the motor and with the lamp, test as indicated in Fig. 6. If the wire between the motor and switch is not open, the lamp should light. If the lamp does not light, it is an indication that the wire between the switch and motor is open, but a further check should be made to make sure that this conclusion is correct. To do this disconnect all three wires at the motor as in Fig. 7 and bring the starting-box arm on the first contact. Then make another test at the starting box as in Fig. 5. After it has been found that the circuit is complete through the starter, then test on the ends of the wires at the motor as indicated in Fig. 7. If the lamp does not light, it may be assumed with a fair degree of certainty that the wire running from the motor to fuse *B* is open. This means that the defective wire must be replaced.

The method of testing the continuity of the wires from the switch to the motor shown in Fig. 7 is the one that would be used where the motor is considerable distance from the starter and the connections shown in Fig. 6 cannot be conveniently used.

Testing Continuity of the Circuits Through the Motor

Where the motor is considerable distance from the starter and switch, the continuity of the circuits through the motor may be tested as in Fig. 8. The armature and field wires are disconnected from the motor and the starting-box arm is placed on the first contact. One terminal of the lamp is connected to the armature wire from the starting box and the other to terminal S_1; this connects the lamp directly across the line through the starting box and the former should light if all wires are complete. Assume a light is obtained, then connect the lamp to terminal *S*. This puts the series-field coils in circuit, and if they are not open-circuited the lamp should light.

If the series-field circuit is found complete, connect the lamp to terminal A_2, which puts both the armature and the series-field coils in circuit. This circuit is from the + side of the line through the starting box and lamp to terminal A_1 on the motor. From here the circuit continues through the armature and series-field coils to terminal S_1 and to the — side of the line. If the lamp were to light when connected to S and not when connected to A_2, it would indicate that the armature circuit within the motor was open. This could be due to the brushes not making contact with the commutator or an open in the leads from the brushes to the external terminals. Note that an open-circuit in the armature winding would not show up as an open through the motor, except in extremely rare cases on two-pole machines when the armature winding is open in a number of places.

By connecting the free terminal of the lamp to F on the motor, the shunt-field coils will be in circuit and the lamp should light if the circuit is complete. The brilliancy to which the lamp lights will depend on the size of the machine. On small machines the lamp may burn very dimly due to the high resistance of the shunt-field coils. On large machines the shunt-field coil resistance will be comparatively low and the lamp will light up to near normal.

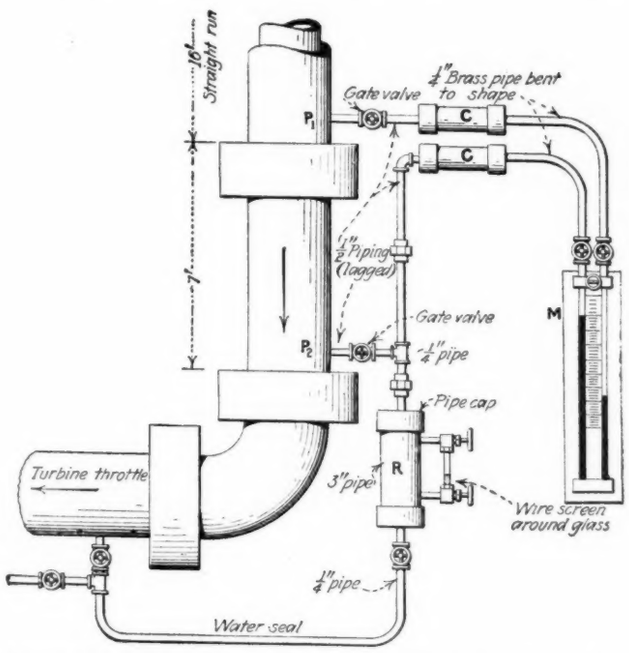
The foregoing does not apply to any machine in particular on account of the way the leads are brought out on different types and makes of equipment. However, the methods suggested show an orderly way to go about testing the circuits to arrive at the seat of the trouble without lost motion. When disconnecting the various wires to make the tests care should be exercised to prevent causing short-circuits and also to prevent getting the connections mixed and connecting the motor up wrong. The next article will show how to test for other faults that will prevent the machine from starting or make it operate unsatisfactorily.

Steam-Flow Determination with a Thin-Plate Orifice

By Edward S. Bristol*

During the last few years much has been published relating to the use of the thin-plate orifice for measuring fluid flow. Such available data, however, will be found in the majority of cases to apply to water and air. Results of steam-flow tests are conspicuous by their absence, probably because of the difficulty and expense involved in conducting laboratory tests with steam. It is commonly assumed that orifice coefficients for water may be transferred to a compressible fluid without exceeding the limits of commercial accuracy. In accepting this assumption, however, a test engineer would be more confident if he had data available showing its degree of accuracy. With the object of securing such a check at one point under common steam-flow conditions, the test here reported was conducted. Incidentally, much was learned as to the precautions that must be observed in making the orifice connections on a large steam pipe.

The opportunity to secure an orifice calibration for steam arose in connection with some water-rate tests made recently upon a 30,000-kw. steam turbine at the Fifty-ninth Street Power Station of the Interborough Rapid Transit Co., New York City. As shown in the diagram, the steam line to this turbine made a vertical drop of some 23 ft. just ahead of the throttle. An orifice was installed in a flange joint in this vertical length. The orifice connections employed were of the type to give the pressure difference depending upon the over-all loss of head, with the upstream connection one pipe diameter from the orifice and the downstream connection 3.85 pipe diameters beyond the orifice. It was not possible to locate the downstream connection at the commonly employed distance of four pipe diameters because of interference with the flange of the lower elbow. However, the difference is believed to be of negligible effect. The straight run of pipe ahead



Arrangement of manometer connections to steam line

of the orifice was approximately ten pipe diameters in length. Other data on the installation are as follows:

Inside pipe diameter, $D = 19.2$ in.
Orifice diameter, $d = 14.50$ in.
Orifice plate, steel, ½-in. thick.
Ratio d to $D = 0.755$.
Normal steam pressure = 220 lb. per sq.in., gage.
Normal steam temperature = 490 deg. F.
Approximate range of flow, 100,000 to 400,000 lb. per hour.

In accordance with common steam-flow-meter practice a pair of condensing chambers C, were mounted at the level of the upper connection, with insulated ½-in. piping extending from the main steam line. With this arrangement the piping from P_1 and P_2 to C is kept filled with steam, while that from C to the manometer M is kept filled with water and the water legs in the manometer connections are equalized. Steam is continuously condensed in chambers C to maintain the equal water legs. Excess condensation and the "spill-over" resulting from changes in the pressure difference work back into the main steam line.

When the manometer piping was first installed, difficulty was experienced due to trapping of water in the connection to P_2, resulting in a false reading of the

*Assistant research engineer, Leeds & Northrup Co.
[1]See report of A.S.M.E. Fluid Meter Committee, Part I, par. 168.

manometer. This difficulty was overcome as shown by adding a small reservoir R with a gage glass and drain cock. By cracking the drain cock so as to keep water in sight in the gage glass it was possible to eliminate the water trap in the piping without disturbing the pressure therein. Afterward R was dispensed with and the drainage piped back into the main steam line as shown. It was necessary to drop this drain connection below its point of discharge so that the resultant water seal would prevent any effect upon the pressure from P_2. Valves were provided for blowing out the water seal occasionally to remove any sediment that might tend to collect.

The method employed to overcome water trapping troubles is set forth in some detail because it will apply to many other cases where it is desired to use an orifice in a vertical steam line. On a horizontal pipe both connections to the condensing chambers are short, so that difficulties of this nature do not arise.

Steam flow was determined in the tests by weighing the condensate from the turbine condenser. The circulating water leakage was very slight, but was determined by chemical test so that proper correction could be made. Differences of pressure as measured on the manometer ranged up to 5 ft. of water. In order to reduce these to a more convenient magnitude, acetylene tetrabromide, with a specific gravity of about 2.95, was employed as the manometer liquid.

The test manometer was calibrated against a water manometer several times during the course of the tests and proved to be stable.

The coefficient of discharge was computed in accordance with the equation

$$C = \frac{Q}{aY\sqrt{2gh}}$$

where

C = Coefficient of discharge, including correction factor for velocity of approach.
Q = Discharge, cu.ft. per sec.
a = Orifice area at steam temperature, sq.ft.
Y = Correction factor for difference in fluid density at P_1 and P_2.[2] This factor may be neglected without resulting in an error over 1 per cent if h is equivalent to not over 1.5 per cent of the fluid pressure.
g = Acceleration of gravity = 32.2 ft. per sec.
h = Pressure difference in feet head of steam at actual pressure and temperature.

Test Supports Chart in A.S.M.E. Fluid-meter Report

As determined from the test data, the average orifice coefficient for a range of flow from 160,000 to 410,000 lb. per hour was 1.115. This figure is in practical agreement with the value 1.12 shown for an orifice ratio of 0.755 by the chart on page 52 of the recently published Report of the A. S. M. E. Fluid Meter Committee. As an orifice coefficient may be found to vary by as much as 1 per cent because of ordinary differences in installation conditions, no undue significance is to be attached to the extremely close agreement found in this instance. However, the test does support the chart in a portion of the field of flow measurement for which published test data are scarce.

[1]For method of determination see Appendix C, par. C91 and C93 of Report of A.S.M.E. Fluid Meter Committee.
[2]For method of determination see Appendix C, par. C91 and C93 of Report of A.S.M.E., Fluid Meter Committee.

Increasing the Output of Oil Engines

Since the fuel per horsepower of an oil engine is fairly constant over a considerable range of consumption, it is often desirable to increase the amount of fuel burned in the cylinder and thereby increase the output without a loss in efficiency. This necessitates the admission of a greater mass of air in order to provide the necessary oxygen for combustion.

In two-stroke-cycle Diesels this plan of supercharging is easily obtained. In port-scavenging units it is only necessary to continue the admission of air at a few pounds pressure after the exhaust ports have been closed. In engines where the scavenging air enters through cam-operated valves, changing the valve-closing points and increasing the scavenging air volume are the chief alterations.

In four-stroke-cycle engines supercharging has not been followed to any extent, inasmuch as the problem becomes somewhat complicated. However, on the two 3,200-hp. Burmeister & Wain Diesels going into the motorship "Amerikaland" supercharging has been provided for. These engines have 8 cylinders, 29.5-in. bore by 47.8-in. stroke and are to run at 110 r.p.m., driving the ship at 12 knots.

Eventually, it is planned to increase the speed of the vessel to 13 knots, which means that the total engine power must be raised from 6,400 to 7,800 indicated horsepower. The engines are designed to permit this more than 20 per cent increase in their output to be obtained when desired.

This is accomplished by replacing the open end of the suction intake with a closed chamber into which air will be continuously discharged by a motor-driven turbo-blower having a capacity of 494,340 cu.ft. per hour.

The pressure within the receiving chamber will be maintained constant at all loads, at 1.5 lb. gage. The compression space in the cylinder will be enlarged by removing distance pieces at the crankpin ends of the connecting rods. In spite of the higher pressure within the cylinder at the beginning of compression, the compression and also the highest ignition pressure will not exceed those that exist when the engine is operating with atmospheric suction pressure, being between 480 and 525 lb. gage. For this reason the shaft dimensions will remain within safe limits at the higher rating.

As the air drawn into the cylinder increases in proportion to the engine load, the normal amount of excess air will still be present, which means that no dangerous temperatures will exist.

This method of increasing the engine power has been thoroughly tested by a 120-hour run of a 1,550-hp. engine. This unit delivered 2,200 hp. at 132 r.p.m. with an average m.e.p. of 118 lb. per sq.in. The mechanical efficiency, including that of the turbo-blower, was 73 per cent, with a fuel consumption of 0.31 lb. per indicated horsepower. The thermal efficiency of 32 per cent does not differ materially from that of the engine at normal load. The engine is started without the blower, and the reduced compression pressure of 400 to 430 lb. is sufficient for ignition. The turbo-blower is put into service as soon as the engine attains normal speed.

Two 1,550-hp. engines on another motorship, whose output was increased to 2,000 horsepower by this method have been in successful operation for over a year. The exhaust valves operate 50 to 70 days without attention.

How Multi-Exhaust Turbine Blades Are Manufactured

FORGING a multi-exhaust type of turbine blade, as in Fig. 1, to the finished size is a more difficult process than that for a vane of uniform section. Manufacturing problems are of a different order than for the comparatively simple process of drawing blading out of ductile metal.

It is to be expected that the more intricate design would require greater care in forming and gaging, but other factors also enter into the problem which again intensify the necessity for precision. In order to comply with the growing demand for larger and more efficient units, which latter depend primarily on the production of suitable blading in the exhaust region, it has been necessary to develop a complete manufacturing routine such as now is in operation at the new blading shop of the Westinghouse Electric & Manufacturing Co. at its South Philadelphia Works.

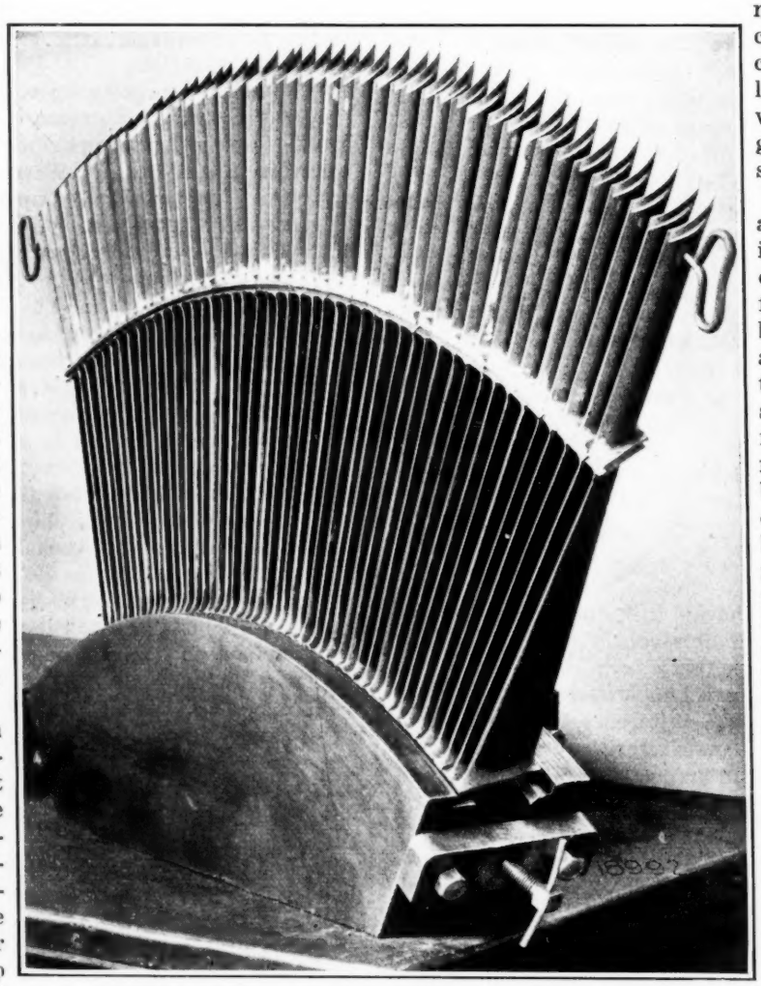


Fig. 1—Multi-exhaust blades two feet in length tested in a slot whose surfaces are turned to same radius as in rotor

It will be seen in Fig. 1, that the particular multi-exhaust (or Baumann) type here shown is constructed of two sections, different in character. The lower blade passes steam at higher pressure than the top section. Also, it is of warped design which permits sharper blade angles near the root than at the shoulder or partition. The relations of blade angles to steam flow are hereinafter described.

On account of the greater distance of the shoulder from the center line of the rotor, this part of the blade section moves faster than that nearer the spindle. The speed of the moving steam is practically the same throughout, so that in order to utilize the steam velocity effectively, the vane angles are varied in accordance with the speed of the vane at each point. In Fig. 2 *C-C* represents a section of the lower blade near the root and *D-D* near the shoulder. Those at *E-E* and *F-F* in order show the sections through the top part of the blade, where the vane angles are not changed. Steam enters at the right of each section, passing to the left.

The reasons for adopting the multi-exhaust type of vane have been widely discussed. Briefly, it may be said that the turbine of largest attainable capacity at any given speed is the most desirable prime mover from the viewpoints of both manufacturer and purchaser. Such a machine represents the lowest cost per kilowatt for a similar general design at this speed.

The capacity attainable in any given type is limited by the area of exhaust vanes, therefore by the length of blade, and in the final analysis it depends on the safe limit of strength of material from which blades are made. Whereas, a turbine with a single row of exhaust vanes may be built to certain maximum safe capacity, an additional moving and a stationary row of the multi-exhaust type would increase its capacity 60 per cent. Also, another similar addition would raise the capacity to 120 per cent of the original without increase of leaving loss in the steam exhausted. A single-flow exhaust is thus provided, which is better suited for connecting to a condenser than the two exhaust openings usually associated with double-flow turbines. It may be apparent, therefore, that expense in perfecting turbine details such as the production of intricate blade shapes is the result of a step in the direction of higher commercial unit economy, representing additional development cost.

Manufacturing generally must be based on standardization of parts, equipment, inspection, shop routine, etc. In many instances the prime object must be quantity, while quality may be allowed as small a margin as is consistently safe for meeting actual requirements.

For many commercial articles, where safety and reliability are not such important factors, conditions

demand that accuracy, smoothness, uniformity, etc., should be no more and no less than what the service actually warrants—in fact success often lies in the closeness with which the minimum limits can be determined and adhered to.

The production of blades for the exhaust region of a large turbine, however, should not be attacked with

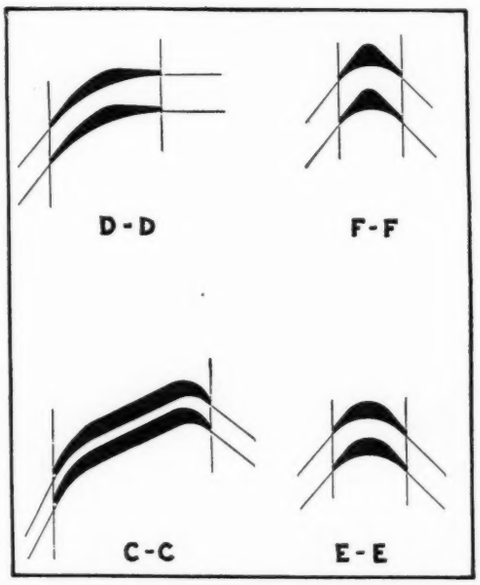


Fig. 2—Showing sharper vane angles at C-C near spindle than at D-D near shoulder, steam enters at the right of each section

such an objective. These vanes are usually worked closer to the safe limit of strength than the shorter blades for regions of higher pressures; safety and reliability are hence more important. Accuracy is in some ways equally necessary, and in other ways, more so. For instance, the surfaces at the root by which a blade is fastened should be machined with a higher degree of precision than for a shorter blade. A deviation from the true shape of the clamping shoulder which would tend to tilt the vane away from its radial position, might be imperceptible at the tip of a small vane, while the same error in the root of a vane two feet long would cause the tip to be seriously displaced. Therefore a degree of accuracy that would answer all requirements for the fastening of a high-pressure blade may be inadequate for one at the exhaust end.

Commercial conditions, as before outlined, also warrant more intricate designs of vanes in the exhaust region. In addition to the sectional type of blade containing a warped surface, the vane is usually tapered from base to tip. This makes for lightness, and anti-vibration tendencies. Also, a thinner section at the root, as at *C-C*, Fig. 2, allows a relatively wider steam passage between two vanes. If the section *C-C*, Fig. 2, were as narrow from right to left as *F-F*, there would not be room between vanes for steam to pass, using the same area of metal as required for safe tensile strength. Difficulty of fabrication, coupled with a pressing need for accuracy, are therefore apparent. The large size of these exhaust blades and being worked closer to the safe limits than high-pressure vanes demand uniformity and reliability to a greater degree.

Quality as a basic manufacturing consideration is thus made more important than quantity, the usual goal of production, as a result of these factors, which all focus toward the same requirement. In the manufacturing routine many operations can be traced to this main objective, so that, although the product thus becomes a costly one, the demands of commercial conditions, as interpreted by accurate forms and dimensions, are squarely met and rigidly complied with.

Scale is the enemy of the forging operation. The 5,000-lb. drop hammer at *A*, Fig. 3, the largest of its kind in this country when built, is not allowed to hit more than three or four blows on one piece. After such a short working period, scale may be formed so the blade is cooled, pickled, cleaned and heated before continuing the operation. Scale is being tapped loose with a hammer at *G*, Fig. 4, removed with a wire brush at *I*, and cleaned from the corners and fillets at *H*. Four

Fig. 3—Largest drop hammer (5,000 lb.) when built, A; die being redressed, B; tempering furnace, C

forging processes are indicated at *E* when this type of vane is being formed from the solid stock, as shown under the foot-rule to the blade at the right. It can be realized that the time and labor spent to prevent the scale spoiling a smooth surface far overshadows that for the actual hammer blows. Precautions against scale are extended to the oil-fired blade-heating furnaces themselves, such as at *F*, Fig. 4. Here the air is made of practically pure iron with some nickel and are heat-treated after forging to finished dimensions. Electric furnaces as at *C*, Fig. 3, with temperature-recording devices bring the vanes to 1,450 deg. F., after which they are quenched in oil. They are then brought up 1,050 or 1,200 deg. and cooled in oil, and finally sent to the machine shop for trimming and finishing.

A machine-shop routine for finishing and checking

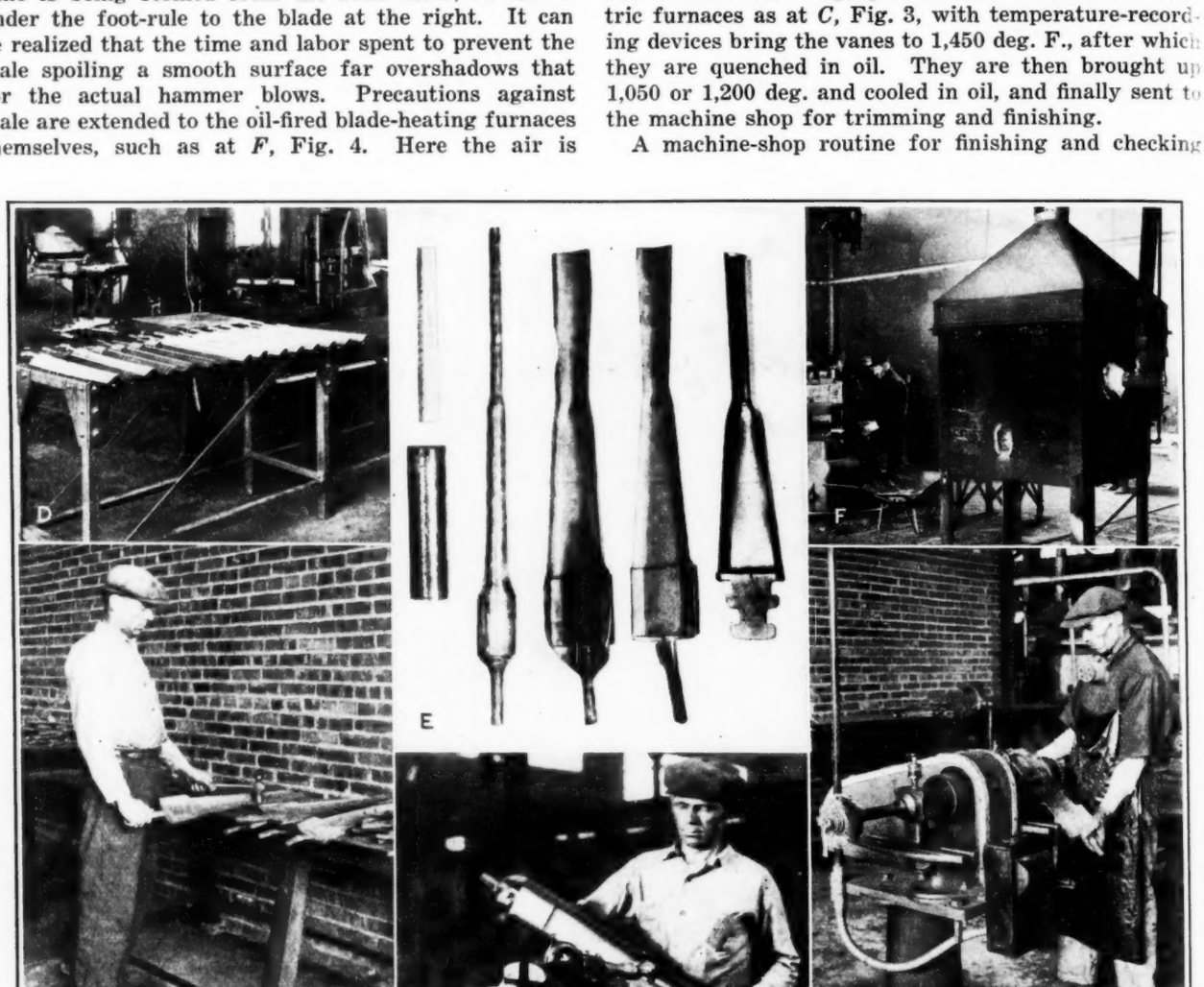


Fig. 4—Stages in forging a type of multi-exhaust vane shown at E. Table with grillwork top, D; oil-fired heater, F; loosening scale with hammer, G; cleaning fillets and corners, H; wire-brushing blade, I

restricted somewhat so as to produce an insufficient oxygen supply, or in other words a reducing flame and not an oxidizing one.

In order to maintain the limits of accuracy, which for forging are as close as 0.002 in. for some dimensions, the temperatures of the metal to be forged must be held close to that for which the mold is designed. The metal flow or displacement when under the hammer, which in general is away from the partition or shoulder for the blade Fig. 1 will then be in accordance with the design of the mold. Each mold is carefully tested and adjusted under favorable working conditions as at *B*, Fig. 3, after the forging of 200 to 300 blades.

Benches for holding hot forgings with a sheet steel top as at *C*, Fig. 3, were found unsatisfactory on account of buckling of the sheet steel from non-uniform contraction and expansion. This condition was obviated by building stands with tops of grillwork or bars which are readily cooled by natural air circulation; such a one supports hot forgings at *D*, Fig. 4. Blades are

was developed along with the forging practice, when the manufacturing of multi-exhaust blades began at one new shop about one year ago. The type in Fig. 1 requires the tips to be milled thin or "profiled" and drilled somewhat below for a lashing wire. The shoulders which must touch each other must be trimmed accurately, as they contact in a circle around the spindle. Since the vane is twisted or warped, there is no symmetrical axis to work to, such as the center line of a cylinder which can readily be located from the exterior surface. The problem of checking or gaging the finished dimensions, warped surfaces, etc., is therefore a complicated one requiring many special devices.

A great deal depends on the degree of precision in machining the tang or root by which the vane is fastened in the spindle. The cylindrical surfaces which must match those in the spindle can be cut with suitable millers by ordinary methods. This could be accomplished by milling against a stationary vane. Greater dependability, however, may be obtained by swinging

the blade about an axis representing the center line of the spindle while the metal is being removed. Surfaces that are thus cut by millers at the proper radius during the rotation of the blade must be truly cylindrical. A vane so machined should tend naturally to extend in a true radial direction from the spindle when assembled, independent of the diameter of the miller.

Gaging the warped surfaces of the dies in which the blades are forged required also the development of special measuring devices. Arrangements for aligning the dies both under the hammer and again on the testing stand also involved the solving of special problems. The wear of the steel surfaces which trim the hot forgings proved a serious factor, and cutting presses were therefore developed in which each piece of cutting steel, when dulled on the original edge, could be turned around so as to present one of several new edges. Thus four cutting edges were available in a single steel cutter after once being completely ground. It may therefore be evident that the actual work in forming and finishing a multi-exhaust blade is but a small part of that required to maintain precision throughout the process.

As a final check on machine work multi-exhaust vanes are assembled in cylindrical slots with surfaces turned to the same radius as those of the spindle shown in Fig. 1. Alignment for radial position, lashing wire holes, shoulders, etc., can be given a final test.

Much of the development of the forging, machining and inspecting equipment and operations was the work of John Fredette, superintendent of tools and equipment.

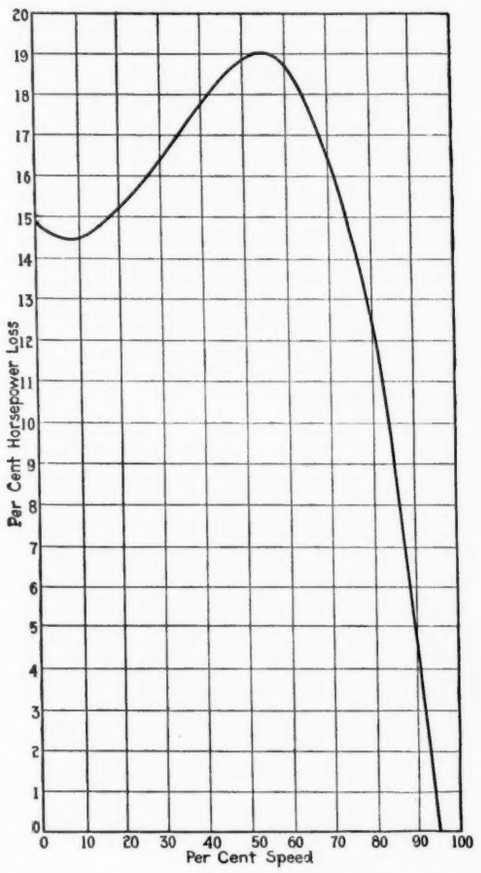
Motor-Control Rheostatic Losses for Centrifugal Pump or Fan Service

By C. H. Chapman*

MANY persons have an indefinite or erroneous idea of the amount of energy that must be dissipated by a resistor that is used for controlling the speed of a slip-ring induction motor or a shunt motor with armature control, used on centrifugal pumps or fan service. The impression as to the amount of energy that must be dissipated is probably formed from the knowledge that the same number of resistor boxes are required for this service as for loads requiring constant torque for the same percentage speed reduction. The amount of energy to be radiated as heat from a resistor for centrifugal pump or fan service, however, does not even approach the amount to be radiated for constant-torque duty when the speed reduction amounts to 20 per cent or more. For loads requiring constant torque the current drawn from the line remains constant irrespective of speed, whereas for centrifugal pump or fan service the torque and, therefore, the line current also vary approximately as the square of the speed.

That the rheostatic loss for centrifugal-pump service is far less than for constant-torque duty is shown by the curve, which was made up to indicate the relation between speed and per cent horsepower loss in the resistor for centrifugal-pump service. On the same basis, using a motor having 5 per cent internal resistance or a full-load speed equal to 95 per cent of synchronous speed, the per cent horsepower rheostatic loss for 50 per cent speed at full-load torque would be 45 per cent. The curve shows the corresponding value for centrifugal pump service to be about 18.8 per cent. In other words, the rheostatic loss for constant-torque loads at this speed is 2.39 times the loss for centrifugal-pump service. Corresponding comparisons can be made for other speed reductions, by remembering that for constant-torque loads the per cent loss is proportional to the per cent speed reduction. By deducting the 5 per cent internal loss the per cent loss in the resistor is obtained.

The resistor for fan and centrifugal-pump service cannot be made to operate throughout the entire speed range at the capacity for which individual sections must be designed. The resistors are tapered in capacity according to the requirements shown by the speed-torque curves for fans and centrifugal pumps. Therefore, when the high ohmic-value sections of the resistors are in circuit, the low-ohmic-value high-capacity sections are not carrying anywhere near the current for which they are designed. For fan or centrifugal-pump service, to give a definite single value of speed reduction, the resistor could be made much lighter than for the same speed reduction for constant-torque duty. However, when designed to give several speed-regulating points at the corresponding torques, the weight and size of the resistor for centrifugal-pump or fan duty will be approximately the same as for constant-torque duty because of this excess capacity of part of the resistor when operating on light loads and low speeds.



Curve showing energy to be dissipated in a resistor controlling the speed of a centrifugal pump motor

*Industrial-Control Engineering Department, General Electric Company.

Engineering Rescued Municipal Utilities

Bellefontaine, Ohio, light and water plants, converted into profitable properties without heavy expenditure. An engineer is now in charge without political interference.

THE rejuvenation of the public utilities owned and operated by the City of Bellefontaine, Ohio, is of interest as portraying not only how municipal light systems are often permitted to deteriorate, but also how they may be rebuilt into efficient structures. Without any large new investment the city was able to recondition its light plant, water-works and artificial gas plant to a point where substantial profits are made each year even though the service rates have been lowered.

In tabulating the procedure leading to such marked improvements, the vital factors may be listed as reconstruction of existing machinery, appointment of an engineer as head of the operating forces, decreased operating expenses, improved character of services, extension of lines and mains and better department morale.

The city's gas works was established when the supply of natural gas in west central Ohio was approaching its end. The gas-making equipment and holders were placed in the central part of the town close to the railroad sidings. In 1907 an electric lighting system was installed, power being supplied by two 225-hp. Diesel engines direct connected to 125-kw. 2,300-volt alternators. The power plant was erected across the street from the gas works.

Later, while drilling for gas at one end of the town, a supply of artesian water was found. This led to the construction of a water-works plant at the wells, the pumping units consisting of a 2½ million gallon per day crank-and-flywheel, vertical steam-driven pump. The capacity was later increased by the installation of a 4 million gallon horizontal crank-and-flywheel pump.

To lift the water from the wells an air lift was used. To supply the air there were a compressor having compound steam cylinders 29 and 20 in. diameter and compound air cylinders 18 and 13 in., with a stroke of 18 in., and a unit having compound steam cylinders 29 and 13 in. diameter and duplex air cylinders 18 in. diameter with a 20-in. stroke are used, and a third compressor with 14- and 22-in. steam cylinders and duplex air cylinders 16 in. diameter and 18-in. stroke.

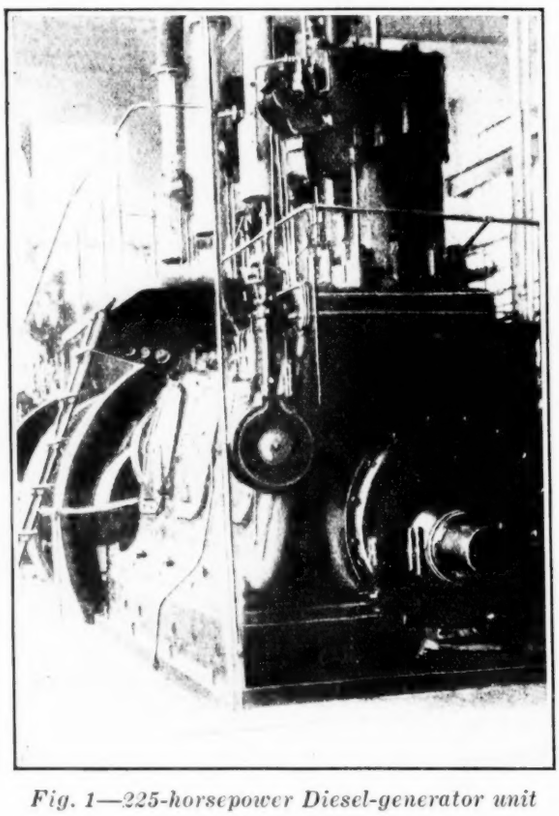


Fig. 1—225-horsepower Diesel-generator unit

The electric lighting demands had steadily increased, requiring an addition to the generating units. Since the system had not been able to accumulate a surplus, the officials were faced with the prospect of issuing bonds. That an oil-engine set cost much more than a turbo-generator unit led to the purchase of a 300-kw. turbine. This was placed in the water works where the boilers were of sufficient capacity to carry the additional load.

In spite of the addition of new machinery in the several plants, service was poor and the financial affairs were in a wretched state. Conditions finally became so grave that in 1920 the Chamber of Commerce employed an engineer to conduct an investigation of the city's utilities, with the idea of formulating a plan of improvement.

The plants were studied as to the condition of the equipment, need of other machinery, operating procedure, etc. The report was illuminating as to how deplorable the affairs of utilities may become through a lack of system. It was found that the departmental organization was such that efficiency was impossible. A Service Director, who was an elective officer, was in charge of the financial branch of the utilities, and technically had complete supervision of the operating force. Unfortunately, this directorship had always been filled by a business man unacquainted with engineering, and as a consequence dependence had to be placed upon the subordinates in all matters pertaining to operation. Each of the three plants was in charge of an engineer who operated his particular plant as he deemed advisable. That this would lead to dissension and poor service should have been apparent.

As the oil engines had never been overhauled, they were unable to carry their ratings and were in so bad a condition that the operator had recommended that they be scrapped. Since the engines operated in parallel with the steam turbine at the water works, each engineer assayed to throw the burden of the load on the other engineer's unit. Line voltage dropped so low at times that it was impossible to keep motors on the lines.

Inspection of the plants revealed that at the water works the efficiency of the labor had dropped so low

that often a boiler was out of service for a week to clean the tubes. Firing was carried on in an extravagant way, and in the pump and turbine rooms things were as bad. The available cooling water was very bad, and the condenser tubes soon were coated with a heavy scale. This raised the back pressure and increased the steam consumption to a marked extent.

After a careful analysis of all the factors of the problem, the investigator recommended that the Service Director be continued as the head of the utilities, but that immediately under him should be a chief engineer who was to have active and actual charge of all three of the utilities. He was to be made responsible for the operation of the plants and of the outside or service departments. The engineers at the plants were to have charge of the particular plants, receiving their instructions from the chief engineer. These recommendations covered the matter of organization.

In reporting on the plants, the investigator dealt with each specific instance of poor judgment or inefficient operation. With respect to the boilers, among other items, it was recommended that the operating force be instructed as to the proper methods of cleaning boilers and the time a boiler should be off the line for cleaning be reduced to ten hours.

The oil engines should be overhauled, so it was recommended, at an estimated cost of $14,000. In addition various improvements were found advisable in the gas works.

The report was passed along by the Chamber of Commerce to the City Council, who acted upon it with the result that the investigator, F. M. Baxley, was employed as chief engineer in charge of the several plants.

The oil engines were overhauled, new cylinders, valves, etc., being installed, at a cost of approximately $14,000, which was covered by a Council issue of bonds. This replacement of worn parts made the engines as good as new, and at the present time they are able to carry their rated load, although almost 20 years old.

The surface condenser of the 300-kw. turbine at the water works was replaced by a jet condenser; the cooling water was put through spray nozzles and stored in the supply reservoir shown in Fig. 5. A cold-process water-treating system was installed for the boiler feed. The operating force were given to understand that cooperation was expected from all and were instructed as to the proper time to overhaul the various machines and how the adjustments and cleaning should be made.

The effect of the reorganization was immediately apparent. Electric, water and gas services soon became equal to those in any community, and by reason of the better operating efficiency rates were reduced by 20

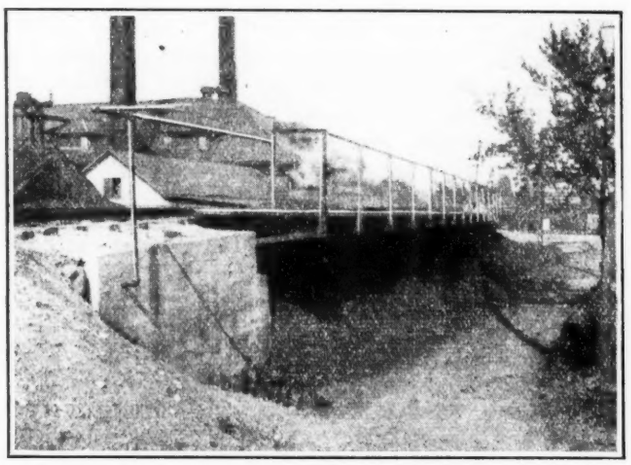


Fig. 2—Coal cars are dumped over trestle onto the storage pile

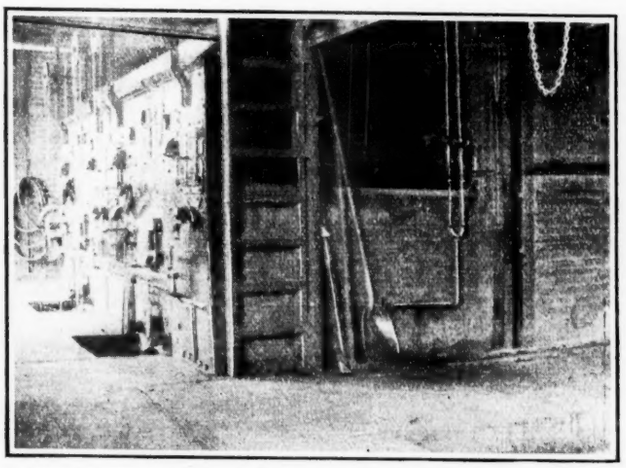


Fig. 4—Vertical water-tube boilers equipped with side-feed stokers

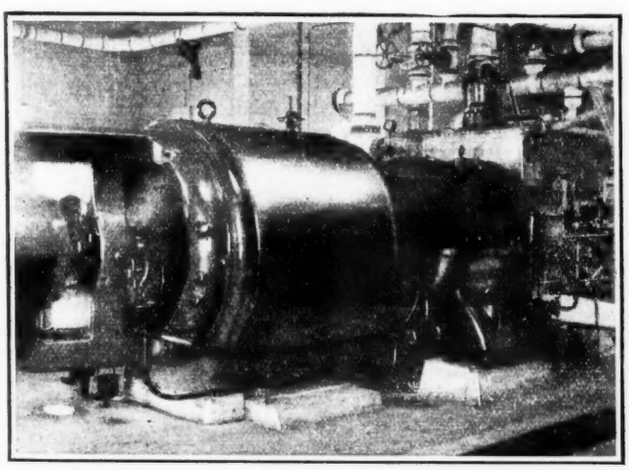


Fig. 3—First steam turbine installed at water works

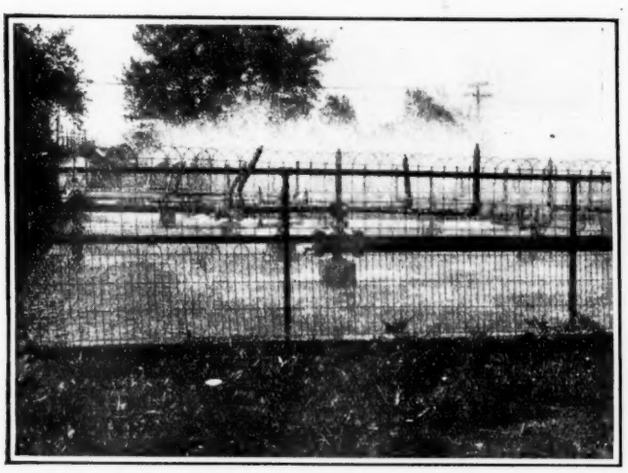


Fig. 5—Spray pond for turbine condenser cooling water

per cent in 1922. The better service led to a greater demand for electricity, forcing the installation of a 600-kw. turbo-generator unit. This was financed by a bond issue which was voted by the city without much objection.

In 1924 a 750-kw. turbo-generator was installed at a cost of approximately $34,000 and has been paid for out of the Light Department's earnings. This made the generating capacity total 1,900 kw., sufficient to handle the load for several years. The reduction in operating expenses in 1924 compared to 1923 was $10,654.

Plans are being prepared to install a coal-conveying system. At present the coal car is run on the trestle shown in Fig. 2 and the coal dumped onto the storage pile. It is then wheelbarrowed into the boiler room, a matter of twenty feet or so. A bucket conveyor will be installed to raise the coal and deposit it upon a horizontal conveyor belt which will run along the boiler

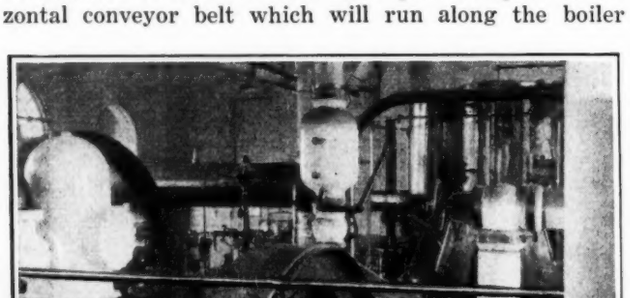


Fig. 6—Steam pump converted to belt drive by motor

fronts over the stoker hoppers. It is also planned to install two more water-tube boilers to care for the increasing load.

In the Water-Works Department the crank-and-flywheel pumps will be replaced by motor-driven centrifugal pumps. The steam consumption of the steam turbines is less than that of the pumping engines, and the change will result in a coal saving. In addition, by pumping at times when the electrical energy demand is low, the turbine will be kept loaded to an economical point. The 14 and 20x16x18-in. compressor has been changed to motor drive, as shown in Fig. 6. The steam pistons were removed to reduce the friction and a 100-hp., 690-r.p.m. motor was belted to the flywheel.

In 1923 and 1924 the Water Works Department was able to install out of the earnings, 9,183 ft. of cast-iron water mains, 2,575 ft. of lead service pipe and 381 meters. The gas plant installed 7,162 ft. of mains and is preparing to put in a new gas bench. The electric-light department installed over 75,000 ft. of service lines. While the greatest reduction in operating costs occurred the first year of the new plan, in 1924 the costs were $4,390 less than in 1923.

During last year 90,111,000 cu.ft. of gas was manufactured, 303,332,899 gal. of water was pumped and 2,776,056 kw.-hr. of electrical energy was produced, of which 801,736 was from the oil-engine sets. The annual load factor of the oil engines was approximately 40 per cent and that of the steam-turbine units 27 per cent.

In making up the balance sheet no credit is made for the street lights, of which there are 312, using 301,344 kw.-hr. annually, nor for the hydrants, of which there are 183. These services should entitle the utilities to a bookkeeping credit of $27,320. The illuminating rate is 7½c.; for power the first 2,000 kw.-hr. is at the rate of 4½c., with a decrease in rate for greater consumption, the minimum being 3 cents.

The present value of the water works is set conservatively at $342,492, but only $84,500 in bonds are now outstanding. The light department's equipment is placed as having a present worth of $285,386, which, with the exception of $117,100 of bonds, has been paid for. Including the gas works the city's utilities are worth $874,664, with a bonded indebtedness of only $283,500. At the present rate of retirement out of earnings the plants will be clear of incumbrances within 10 years.

OPERATION OF BELLEFONTAINE PUBLIC UTILITIES

Water-Works Receipts

Collections:	
Flat rate water	$23,478.40
Metered water	28,484.20
Sale of water	80.11
Miscellaneous	226.98
Installation of meters	1,260.00
Interest on deposits	140.45
Refunds	24.25
Total receipts	$53,694.39
Balance Jan. 1, 1924	2,341.43
Total receipts and balance	$56,035.82

Water-Works Expenditures

Office:	
Salaries	$1,215.00
Furniture and fixtures	132.06
Stationery	241.81
Incidentals	151.81
Supply:	
Maintenance	3.45
Pumping:	
Operation	15,677.75
Maintenance	2,207.94
Distribution maintenance	3,595.98
Extensions:	
Building and equipment	1,069.03
Mains and services	6,565.78
New meters	3,833.47
Refunds	24.25
Bonds and interest	10,965.00
Total expenditures	$45,682.86
Balance Dec. 31, 1924	10,352.96
Total expenditures and balance	$56,035.82
Earnings	25,479.81

Electric-Light Plant Receipts

Collections	$123,047.35
Refunds	90.12
Deposits for service	508.00
Interest on deposits	414.64
Sale of real estate	1,101.00
Total receipts	$125,161.11
Balance Jan. 1, 1924	13,046.73
Total receipts and balance	$138,207.84

Electric-Light Plant Expenditures

Office:	
Salaries	$2,535.00
Furniture and fixtures	130.64
Stationery	693.62
Incidentals	193.76
Manufacture:	
Operation	52,137.20
Maintenance	3,498.20
Distribution maintenance	8,938.20
Return of deposits	293.00
Refunds	90.12
Extensions:	
Buildings and equipment	21,972.53
Lines and services	5,156.98
New meters	1,610.72
Bonds and interest	17,000.00
Total expenditures	$114,249.97
Balance Dec. 31, 1924	23,957.87
Total expenditures and balance	$138,207.84
Total operating receipts	123,461.35
Total operating costs, including interest on bonds	74,488.12
Earnings	$48,973.13

Compensation Versus Specifications

A CIRCULAR is being sent out by the Civil Service Commission announcing an open competitive examination for "second-class steam-electric engineman." In order to qualify, the applicant must have an intimate knowledge of the construction, operation and repair of boilers, engines, turbines, condensers and other power-plant equipment, including both direct- and alternating-current generators, motors, switching equipment and distribution systems. In addition, he must be thoroughly familiar with heating plants. And the compensation? This is specified as $1,320 a year to start, with advancement possible up to $1,680 for the District of Columbia.

It matters not so much what title the position may carry, and it may be that the actual duties involved in this particular vacancy do not warrant more, but it is unmistakable that the qualifications demanded require a training and experience for which the salary is not at all commensurate. If the duties do not warrant greater remuneration, the specifications should be fixed accordingly and not made to cover those of a high-grade experienced operating man.

Such practice not only tends to create a false impression as to the value of such services, but it also stands in the way of the government's securing the right man for the place.

The Refractory Investigation

OWING mainly to the great increase in boiler-furnace temperatures and rates of combustion, the construction and maintenance of furnace walls has of late years become a problem as knotty as it is financially important. The larger stations, as pioneers in the operation of mammoth boilers at high ratings and efficiencies, have by force of necessity given much thought to this problem. Progress has been made. Improved refractory materials and shapes have been developed, along with methods of furnace construction calculated to protect the walls from excessive temperatures, allow for expansion and contraction, relieve hot brickwork from the dead weight of high walls and otherwise give the refractory materials a better chance of long life. But the problem is so large and the factors involved in refractory failure so varied and interrelated, that a broad solution is unobtainable by piecemeal attack.

No adequate study of this problem had been attempted prior to that initiated about a year ago by C. F. Hirshfeld, Chief of Research Department, Detroit Edison Company. The United States Bureau of Mines undertook to carry on the investigation with the active co-operation of eighteen companies operating large central stations. A report has just been issued covering a preliminary field survey made to determine as definitely as possible the factors governing the failure of refractories in various types of installations. The conclusions are outlined in the leading article of this issue. An accompanying report, classifying boiler-furnace refractories, with concise statements of their physical and chemical characteristics and brief outlines of their methods of manufacture, will appear in next week's issue.

While there may be some question as to the applicability to plants in general of certain conclusions based on a study of central stations exclusively, the preliminary report is valuable because it pictures the problem as a whole, incidentally giving some information capable of immediate practical application. The Bureau of Mines has repeatedly proved its value to industry, and the present report gives promise of still another substantial contribution. Only one suggestion comes to mind. The work as at present outlined will apparently be concerned mostly with conditions as they exist in the larger stations. It is to be hoped that later, if it is not feasible to do so now, the scope of the investigation may be broadened to include the special conditions found in industrial plants.

Importance of Plant Improvement to the Management

SINCE power usually represents a small percentage of the cost of a manufactured product, a proposition involving increased plant efficiency is not likely to receive as enthusiastic a reception as one involving an equal expenditure in some other department. It appears, however, from some viewpoints, that efficiency in power generation and distribution is gaining in importance. During the last few years the rise of fuel and labor prices has forced many small plant improvements. At the present time, however, additional factors in favor of higher plant efficiency seem worthy of consideration.

Statistics indicate that the production per man is steadily rising and that power is therefore becoming of greater moment in manufacturing. Not only this, but from the fact that distribution of products is being made more of an exact science, one probable effect will be the closer co-ordination of production with demand, leading in the end to greater competition for the actual profit. In other words, although the bulk of things manufactured is expected to maintain a high yearly average, it will become more and more necessary to cut expenses. The glaring waste characteristic of many small plants may be recognized as a substantial factor in the final balance between profit and loss. If a possible yearly saving be translated into terms of the payroll, indicating how many men could be dropped if a similar economy were made in labor-saving devices, the story of the engineer may receive added punch.

By combining energy production with supplying low-head heat, a thermal efficiency from coal to electricity equal to twice that of the best condensing station can, under favorable circumstances, be obtained. The manufacturing plant may, however, even go further if desirable and adopt boiler-room improvements to increase the efficiency beyond this point and often to diminish labor and upkeep at the same time. Assuming that it is decided to revamp, the engineer can now point to many examples of improvements worked out within the last few years, materially increasing what were formerly good boiler efficiencies.

Synthetic Alcohol Not a Fuel

THE dumping of larger amounts of German synthetic alcohol on the American market has upset the wood-alcohol industry. It is now announced that a patent covering the synthetic process has been found among those held by the Alien Property Custodian, and that American firms are experimenting with the process. The public press, as usual, has seized upon this as the basis of distorted news stories of the possibilities of this alcohol replacing gasoline as a fuel.

The price the automobilist pays for his gasoline includes much more than the mere cost of the crude and the refining expense. The retailer exacts from two to four cents per gallon, the railroads demand three or four cents, while the jobber and refiner must each draw tribute. It is not surprising then that a gallon may cost the individual as much as twenty-five cents even though the cost to the refiner may be as low as six cents.

No estimate of a manufacturing cost of less than ten cents has been made by anyone acquainted with the synthetic process. Inasmuch as almost two gallons of alcohol are needed to equal one gallon of gasoline in heat value, the relative cost of alcohol is about eighteen cents, over twice the manufacturing cost of gasoline.

As a substitute for wood alcohol used in industrial processes, the synthetic product will find a ready market, but gasoline will continue to be the favorite for the internal-combustion engine, save in those localities, such as Cuba, where gasoline is expensive and alcohol very cheap. Nothing prevents the experimental use of alcohol in existing engines. Even though the engine will be sluggish at starting, its behavior will be satisfactory as soon as the cylinder walls become warm. The efficiency, however, is low as long as present compression pressures are used.

The constant search for a new internal-combustion fuel is not due to a dearth of gasoline, but is mainly to make possible an increase in compression pressures. Gasoline cannot withstand high pressures without detonation, and as long as the fuel is carbureted efficiency must be sacrificed. The logical procedure is to abandon the method of fuel feeding through a carburetor and to inject the gasoline directly into the cylinder at the moment of ignition. In this way compression pressures could be carried as high as desired. Some experimental work has been done along this line, but has suffered from the lack of financial support.

A solution of the fuel introduction problem offers far greater returns than does any of the anti-knock compounds or another hydrocarbon such as alcohol. The road to greater efficiency is so plain that it is strange that the larger organizations have played with anti-detonating liquids.

Fewer Sizes in Pipe Fittings and Valves

IN LINE with the splendid work which Secretary Hoover has initiated in the elimination of waste through simplified practice and standardization, one of the large manufacturers of valves and pipe fittings has undertaken to eliminate from its standard line a number of odd sizes which are to be placed in a list of special made-to-order items. To this end the co-operation of other manufacturers in this line is being sought.

Many such sizes are a result of competitive conditions and a lack of appreciation on the part of the purchaser. Not only have they been unprofitable to the manufacturer, but they have been reflected in a higher cost to the user, although the latter may not have always been aware of this fact. It is upon this score that the purchaser must be made to sense a personal advantage in accepting a greater degree of standardization. Without his aid the manufacturers, however willing to co-operate, will find difficulty in putting the idea into effect.

Although there has been some standardization in such fittings, considerable more is possible without inconveniencing the purchaser, and the manufacturer who has initiated this latest move is to be commended.

One sometimes hears of furnace brickwork "melting." An investigation of eighteen central stations by the Bureau of Mines (see page 234 of this issue) failed to reveal a single case where refractory failure was due to fusion of the bricks by temperature alone. Where fusion does occur, it is generally due to slag action. A combination of ash and firebrick, for example, has a lower softening point than either alone. The present need appears to be not for refractories of higher fusion temperature as determined by laboratory tests, but for those that will give the minimum trouble from spalling, slag action, softening under load, thermal expansion and contraction and similiar effects.

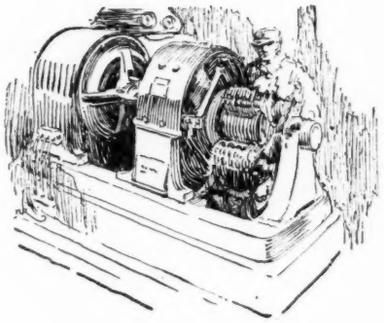
At a cost bitterly high in life and property the sea has taught a great lesson, embodied in the single term "shipshape." Nothing but unremitting attention in fair weather, to spars, rigging, sails, hull, deck and every odd block or coil of rope holds off disaster in time of storm. It is much the same on land and in the power plant. The engineer who is "lucky" in emergencies is generally the one who keeps things in shape when the going is good.

The Fuels Committee of the A.S.M.E. has renewed its activities toward smoke elimination. Here is one of several opportunities where the professional society can apply its technical knowledge to the public welfare and in return receive the recognition due it.

The anthracite operators and miners seem bent upon creating a condition that may ultimately force the Government to take a hand.

After several false starts the Sesqui-Centennial Exposition appears to be finally headed in the right direction. To what extent it will be able to make up for lost time and effort is a question that many are now asking.

Practical Ideas from Practical Men



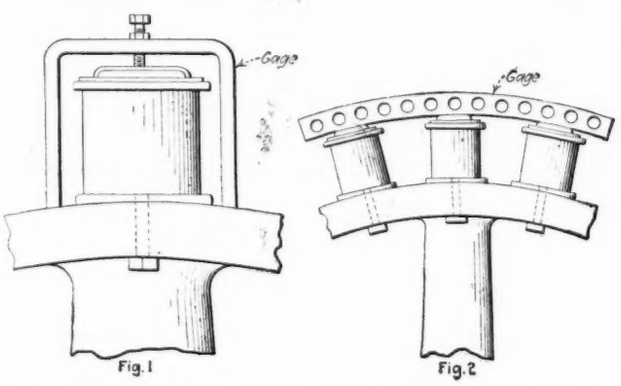
WITH a view to stimulating engineers into the habit of recording for the benefit of brother engineers, unusual occurrences, how these were met and other practical expedients adopted in the operation of their plants, Power has decided to award two cash prizes each month during 1925. One of $25 for the best and another of $15 for the second best practical letter on plant operation or practical kinks received during the month. This is in addition to payment for the contribution at space rates. The winners for July will be announced next month.

Installing Alternator Field Coils

Transportation often makes it necessary or desirable to remove the polepieces and coils of alternating-current generators. If these are held in damp storage for some time or if the power house is in a country of heavy rainfall and high humidity, the coils will absorb moisture. This moisture will swell the veneer boards and also the insulation between turns. As a result of this swelling the field coil may be high enough to prevent pulling the polepiece down until it bottoms iron to iron on the rotor rim. It is important that the polepiece and rim come solidly together, and a check must be made to prove they are tight and bottomed.

One method that is more or less standard is to make a gage that will straddle the pole and check the elevation of the top of the pole, Fig. 1. Another scheme is to machine a gage to the circumference of the circle tangent to the pole faces and long enough to span several poles as in Fig. 2.

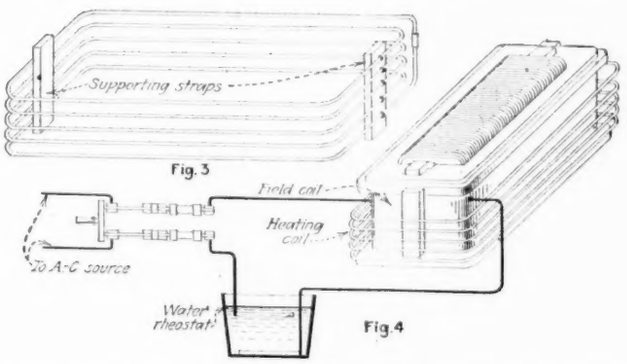
The simplest and probably the best way is to file a groove in the inside face of the bottom veneer board



Figs. 1 and 2—Methods of gaging position of field poles

at each end of the pole. On long poles similar grooves should be filed at points along the sides of the pole. These grooves should be slightly wider than the leaves of a set of feelers, and a few thousandths of an inch deep. The feelers can be used through these slots to prove positively that the poles are bottomed. The bolts or keys should then be tightened snugly and tested. If the poles cannot be drawn down, the field coils should be heated with current to dry out the moisture. This is a simple problem where direct current is available. The current required is about the normal field current of the machine.

In many cases, especially new installations, direct current is not available, but alternating current is. In applying alternating-current, the impedance of the field coils is a factor that must be overcome if satis-



Figs. 3 and 4—Method of heating field coils with alternating current by placing secondary coil around pole piece

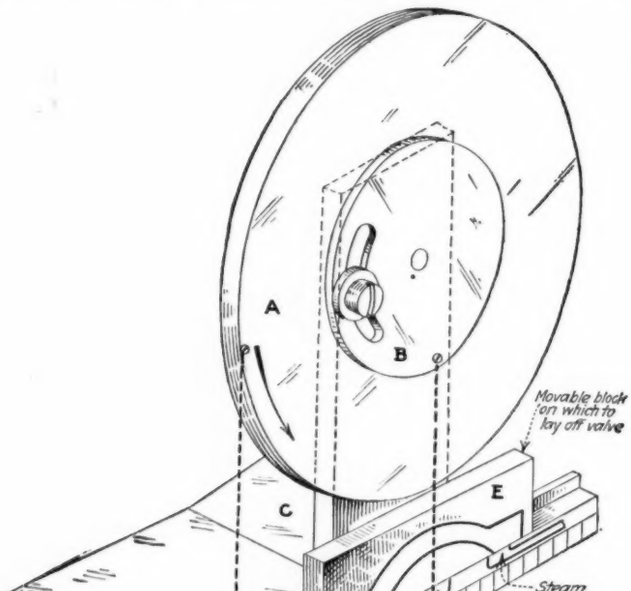
factory heating is to be obtained. A way has been worked out for overcoming this difficulty. A rectangular coil of five or six turns of No. 00 or larger wire is made. Scrap trolley wire will serve the purpose nicely. This coil should be large enough to slip over the field pole with the field coil in place and the complete pole bolted or partly keyed to the rotor. The ends of this coil are brazed together, and it can be kept in shape with iron straps across the ends, Fig. 3. The general arrangement of doing the heating is shown in Fig. 4, where a water rheostat is used to control the current through the field coil.

The addition of the secondary coil makes the field coil a transformer with a short-circuited secondary which cuts down the impedance and gives enough current at a reasonable voltage to heat the field coil thoroughly. The secondary coil will get red hot, and the heat radiated from it will assist in drying the insulation. Care should be taken to keep the field coil from getting hotter than 90 deg. C. measured by thermometers. In general, full-load field current of the generator can be safely used. The bolts should be tightened or the keys slowly driven as the coils dry out, until the iron of the bottom of the pole is solid against the rotor rim. This can be determined by the methods previously explained.

N. L. REA,
Contract Service Department,
Schenectady, N. Y. General Electric Company.

Device for Illustrating the Operation of a Slide Valve

In looking over some old papers, I found a sketch of an apparatus that I had made for use at meetings of the N. A. S. E. at Portsmouth, Ohio, to illustrate on a large scale the operation of a slide valve, showing the effect of changes in lap and lead. It occurred to me that it might be of interest to some readers of *Power*, as there are a number of slide-valve engines still running.



Details of device used to illustrate action of slide valve

The entire apparatus is of wood and consists of a large disk *A* representing the crank of the engine, a smaller disk *B* representing the eccentric, an upright *C* and a baseplate *D*. Along the base which is in line with the face of the large disk is laid out the length of the cylinder. A screw is placed close to the edge of the disk, and a plumb bob is suspended from it. The smaller disk *B* of thin lumber is mounted on the same horizontal axis as the larger disk and is attached to it by means of a screw and washer through the circular slot. The disk should be of sufficient diameter to study any engine with the screw set so as to have the eccentric throw full scale.

On the base above the scale representing the length of the cylinder, is a space on which to attach a drawing of the valve seat showing the parts full size. Sliding on the base is a block of wood *E* representing the slide valve. On this block a paper can be attached representing the valve to be studied drawn full scale. A plumb bob is suspended from the screw in the eccentric. The outer screw with its bob indicates on the scale on the base the position of the piston. The valve is moved by hand to make the plumb bob string cut the center line of the valve at all times. The lead is adjusted by means of the screw and slot. Any variation of the outside lap can be made on the paper drawing of the valve and the lead changed to suit.

This apparatus is not exactly true, as it does not take into consideration the angularity of the connecting rod and the eccentric rod. The piston is assumed to be only as thick as a line, so that the entire cycle can be studied.

I found this device useful in checking slide valves found in old engines built even before the Civil War. Some of these engines, which had been running fifty years, had valves so badly designed or changed after design that a new valve made a saving of 50 per cent in fuel.

SAMUEL P. BAIRD.

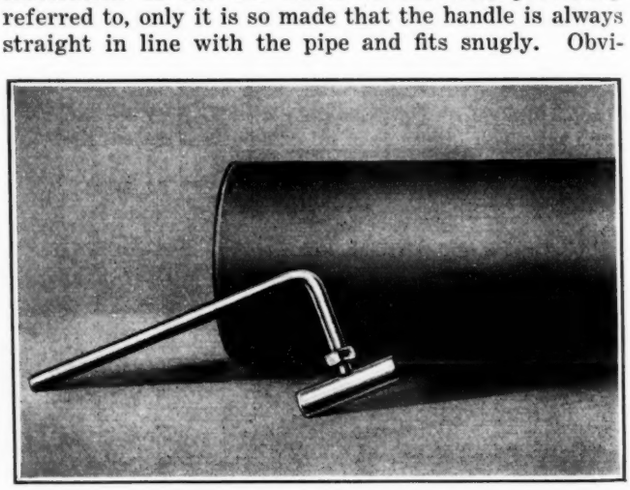
Columbus, Ohio.

Adjustable Handle for Carrying Pipe

It is often impossible, owing to obstructions, to move pipe, tubes, etc., any other way than by hand, and when the material is of large size it requires a man at each end to carry it. Pipe above 3 in. diameter cannot be handled conveniently by hand, nor can the fingers be placed in the ends, as these are often burred up and sharp.

Noticing that the man engaged on this work frequently made use of a bar thrust in the end of the pipe, an interested executive designed a special bar handle and made it adjustable so that various sizes could be carried with it.

This handle is shown in the illustration alongside a pipe it has been adjusted to fit. The idea is an elaboration of the bar stuck in the end, previously referred to, only it is so made that the handle is always straight in line with the pipe and fits snugly. Obviously, when an ordinary bar is used, it lies at a rather awkward angle and the hands tend to slip toward the end.



Handle is adjustable to several sizes and lies parallel with pipe

The adjustable handle, shown in the illustration, is made of ¾-in. round stock bent at right angles at one end. This end is tapped out for a screw, which is riveted to a short length of larger stock. A locknut completes the tool. To make the handle fit any size of pipe from 6- to 10-in., the nut is loosened and the screw adjusted until the device will just slide inside, then the nut is tightened. In use the tool is shoved well into the pipe with the bent-over handle on top.

Montreal, Que., Canada. H. MOORE.

Comments from Readers

Measuring Coal on Traveling Grate Stokers

In the June 16 issue of *Power* Mr. Ogur discusses the subject of coal measurement on traveling-grate stokers, giving a clear presentation of the necessity for accurate measuring instruments in the power plant and bringing out the danger of approximations in arriving at correct plant efficiencies.

In connection with the use of coal meters on chain grates one point with which many engineers are not familiar is that these instruments, under the name of the "Lea Coal Meter," have been tried out thoroughly and proved successful in Great Britain and several foreign countries during the last eight years. Some of the large corporation electric works in the cities of England alone may be cited: Blackburn has 21 meters; Bradford, 25; Halifax, 14; Preston, 15; Salford, 18; Sunderland, 10; Wallasey, 13; Derby, 12; Nottingham, 18; Stoke-on-Trent, 12; Charing Cross, 26; Metropolitan Electric Works, 16; Edinburgh Electric Works, 22; Greenock, 13; Kirkcaldy, 10; South Wales, 18; Belfast. 24; and many others, including some of the largest plants on the continents of Europe and Asia.

In addition to these installations there are a considerable number of coal meters manufactured under the Lea patent which have been giving satisfactory service in the United States during the last year and a half. Repeated tests have shown that a properly designed coal meter will give day in and day out accuracy sufficiently close for all practical purposes.

To begin with, coal weighing in the average plant is the most inexact data obtained. No operating man will base his cost figures on coal weighed to a boiler house unless they are checked monthly by an inventory of coal on hand and car weights received during the month. If this precaution is not taken, there will be a difference to account for when the coal stock is checked. The plant must pay for the coal received on the basis of mine weights. Weight of coal received varies with the season of the year, depending upon moisture absorbed in transit or storage. Coal from a particular source will run nearly constant in moisture content when weighed at the mine. Consequently, a charge for coal based on the volume used and the weight per cubic foot for dry coal will give a dependable check. Errors of observation and neglect are notorious unless the weighing is closely watched.

In the last analysis the operator has the problem of computing a total charge for the month for coal. This is a definite figure and cannot be questioned if due regard is taken of receipts and stock on hand. Now, if there is one boiler in service, the whole amount is chargeable against that boiler. In case of several boilers it is desirable to obtain the charges per boiler, if possible, at a reasonable cost.

We are glad that Mr. Ogur indorses the rationality of the volumetric measurement of coal. In view of the large number of highly satisfactory installations already mentioned, it has been demonstrated definitely that the "thickness of fire" has a constant relation to the gate opening for any particular kind or grade of coal. Mr. Ogur compares the coal meter to a counter on the reciprocating pump. This is hardly a correct comparison. We believe that a weir meter is a better analogy, both as to application and results obtained.

To sum the matter up, the fact that coal meters work and give dependable results is the final argument and one that hardly can be contested.

Chicago, Ill. M. J. EVANS,
Republic Flow Meters Co.

Star-Delta Connected Transformers

The answer given to the question on the star-delta connected transformers, page 67, July 14 issue, while correct, does not state the possibilities of the connections completely. It is possible to use two transformers of three in a star-delta bank to maintain service when one of the transformers in the bank is burned out, if these transformers are operating on a four-wire three-phase circuit.

It is becoming general practice to distribute energy at 4,000 volts with a three-phase four-wire system. This allows standard 2,300-volt transformers to be used and connected in star on the 2,300-volt side and delta

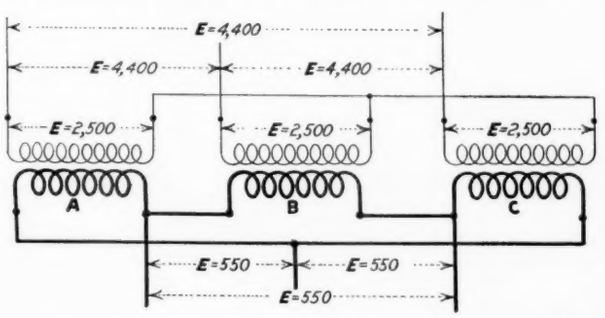


Fig. 1—Three transformers connected star-delta

on the low-voltage side. The neutral conductor, or fourth wire, may or may not be connected, depending upon the nature of the load, and in the case of a three-phase motor load it may not be connected. Should one of the transformers burn out, it may be disconnected and the two remaining transformers will then operate at reduced capacity by connecting in the neutral wire. The low-voltage side will operate open delta. Fig. 1 shows the star-delta connections complete and Fig. 2 the connections with transformers *C* cut out of circuit.

Whether the neutral connection will be grounded will depend upon the operating company's practice. Usually, there may be one system ground at a substation and the banks may or may not operate with the neutral of the bank grounded or connected to the neutral conductor.

The connection shown in Fig. 2 will cause the neutral

conductor to carry the load current of the bank, and is to be considered as an emergency method only. The capacity of the neutral conductor must be taken into consideration. If this is smaller than the main line

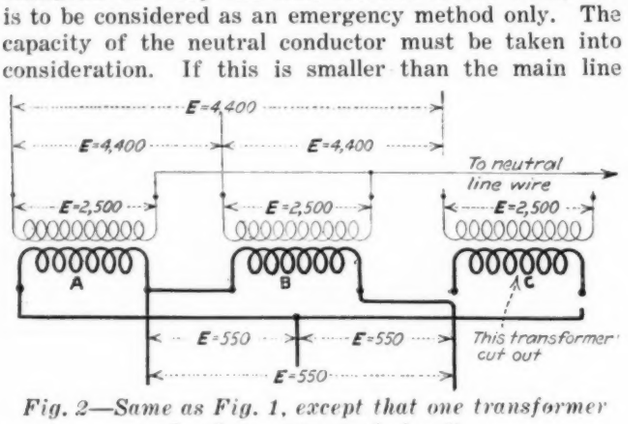


Fig. 2—Same as Fig. 1, except that one transformer has been cut out of circuit

wires, it may be the determining factor in the amount of load that can be placed on the transformers.

Springdale, Pa. C. OTTO VON DANNENBERG.

Energy Storage

The method for energy storage proposed by Mr. Lagerquist in the June 30 issue is most ingenious and, if the energy of combustion could be used directly to decompose the water, would provide an ideal system of energy storage. But since the record transformation of heat into electricity by steam power is around 13,715 B.t.u. per kw.-hr. and assuming 100 per cent efficiency all the way through and no power required for compressing the decomposed hydrogen and oxygen to steam pressure (though I suppose this decomposition could be done in some sort of a pressure apparatus), the gases would have only 3,412 B.t.u., the equivalent of one kilowatt-hour of energy, to release on recombination, so that the efficiency of storage under the most favorable conditions would be only about 25 per cent.

There was recently published (*Combustion*, June, 1925) a very elaborate study of the apparatus required for thermal storage to flatten out the boiler load curve of a fair-sized central station which showed not only that the accumulator form would be nearly as large as the station itself, but that the B.t.u. per net kilowatt-hour would be increased in the thermal storage station owing to the necessity of using stored heat at a lower temperature than that at which it was stored and that at which the heat supplied directly from the boilers was available.

Several years ago, while employed by a boiler company, I investigated a system of thermal storage by means of auxiliary boiler drums for storing and heating water during off-peak periods to provide a source of hot feed water during peak-load periods, thus increasing both capacity and economy. It was found, however, that the drums and supports with this auxiliary apparatus would be much more expensive per horsepower of increased capacity than a corresponding amount of increased heating surface and that the increased economy would be hard to find. From these examples I am led to believe that with present equipment and fuel costs the accumulator or thermal storage in general is now commercially limited to comparatively short time cycles such as evening up the supply and demand of a low-pressure turbine fed by the exhaust of steam hammers or similar conditions, where rather high rates of B.t.u. input and output occur, but neither for so long a time as to require the storage of a large amount of heat.

It was reported that considerable progress had been made in Germany shortly before the war in the use of an accumulator similar to a gas holder, suitably insulated, in which the steam was stored as vapor, but little has been published on it since then. This would have a thermodynamic advantage over the water-storage type in that the steam could be drawn off at practically the pressure and temperature at which it entered, whereas in the water-storage type it is being stored at a gradually increasing pressure, reducing the efficiency of the apparatus which it is leaving and discharging at a gradually decreasing pressure, reducing the efficiency of the apparatus in which it is being used.

New Haven, Conn. H. D. FISHER.

Pulverized Coal vs. Stokers

With reference to the comments of Edwin Lundgren in the issue of Jan. 20, relative to Pulverized Coal vs. Stokers at Brunot Island Power Station, Mr. Lundgren claims that pulverized coal is more economical than stokers on account of the fact that the new Fourteenth Street station of the New York Edison Co. will be installed with pulverized fuel.

Under these circumstances it might be of interest to Mr. Lundgren and to the other readers of *Power* to know that the engineers of the Philadelphia Electric Co. have decided in favor of multi-retort stokers for their new Richmond Station, 600,000 kw., which will be the most modern and largest power plant in the world, a fact that speaks for itself.

Concerning the stoker test made at Hell Gate Station, Mr. Lundgren seems to suspect, though the results are already good, that these might be improved by using a more modern device. In fact, the device tested at Hell Gate Station is not in reality a new one, and Mr. Lundgren, a designer of stokers, well aware of European patents, is in better condition than anyone else to know that this device was designed and patented in Europe more than 13 years ago.

In spite of that serious handicap in comparison with the more modern pulverized-fuel devices, the efficiency obtained has been at least as high as with pulverized fuel. On this subject it might be well to compare the results of Hell Gate Station to those obtained at Lakeside Station, both tests having been witnessed by the same eminent engineer, John Blizard. The results at Hell Gate Station, published in *Power*, are:

Duration, Hours	Rating, Per Cent	Efficiency, Per Cent
28	181	92.7
25	170	89.6

The leaflet Serial No. 2,438 Jan. 1923, of the Bureau of Mines gives for the test at Lakeside Station and for nearly corresponding ratings and durations:

Duration, Hours	Rating, Per Cent	Efficiency, Per Cent
25.57	178	88.4
24.03	170	89.3

These results seem to corroborate the opinion I have advanced, which E. L. Hopping, in *Power*, issue of June 23, seems to confirm when, speaking of the final result of the stoker vs. pulverized fuel (cost of current at the busbars), he says: "We believe it will be slightly better."

Now, Mr. Lundgren and the other readers of *Power* will certainly agree that the power used to grind the coal, to deliver air at 10 in. water pressure for some

devices or to 15 lb. and even more for other devices, is higher than the power required for a stoker for pushing the coal and delivering air at 2 or 3 in. of water pressure.

Moreover, there is no doubt also that the operation of grinding needs a high upkeep without taking into account the erosion of fittings especially at the elbows, fan impeller and casing, capital charges and others pointed out by Mr. Hopping and as is the case with pulverized fuel.

In addition there is another question, and this is the ash problem. On this subject I think that Mr. Lundgren and the other readers of *Power* will not deny that the percentage of ash swept through the heating surfaces is much higher with pulverized fuel than with stokers. This sweeping of ashes causes many troubles.

In his article in the issue of June 23, "Slag formation in Tubes of Powdered-Coal-Fired Boilers" J. G. Coutant refers to tests at the Société des Mines de Blanzy, France and says "130 per cent rating could not be maintained for any length of time and slag formed readily at 140 per cent rating."

This trouble is not peculiar to this installation, but is found in French and Egyptian plants as well as those of any other country.

This slag formation results in series faults. At first, it forms insulation of the heating surfaces and lessens the efficiency. Moreover, to avoid clogging of the draft and be able to work the boiler, soot blowers have to be used every hour. Take in consideration the great consumption of steam and the cooling resulting from the expansion of this steam through the heating surfaces—cooling plainly noticeable on the steam charts for example—it is obvious that these factors are not precisely made to increase the final efficiency.

Furthermore, consider the amount of combustible swept in the flues with the ash—figures obtained in French plants are as high as 74 and 84 per cent—you will find this is another reason of lessening the efficiency. On this subject the efficiency of French plants installed with pulverized fuel and referred to by Mr. Coutant in previous articles is hardly 80 to 82 per cent for water-tube boilers equipped with superheater and economizer.

All these facts seem to confirm plainly the opinion I have advanced that when investigation is thorough the stoker is more economical than pulverized coal.

It is my opinion, too, that with some slight improvements it would be possible to eliminate some faults of the existing underfeed stokers and more especially the fundamental error in the realization of the underfeeding principle, as is the case with the existing devices. I have discussed this point in previous articles.

Moreover, I believe that it would be possible with improved underfeed stokers to use every grade of fuel. Careful observation of phenomena occurring on working stokers has corroborated this opinion. In a power plant in Ohio entirely equipped with underfeed stokers one of them was supplied with a small agitating grate driven by means of a steam ram. I have observed:

When using *good* coals the grate is shaken every *25 minutes.*

When using *bad* coals the grate is shaken every *5 minutes.*

Consequently, it is necessary to shake more and more often the fuel bed according to the decreasing of quality of coal, hence the possibility of using a much larger range of grades of coal if using a continuous shaking and extending this shaking to the entire surface of the furnace.

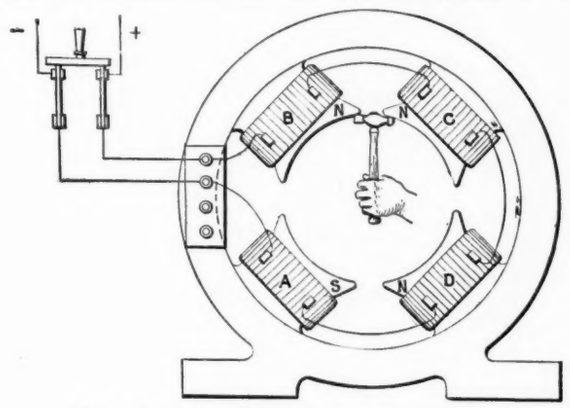
Such careful observation would lead to the real philosophy of a combustion engineer, which is to improve inefficient devices by carefully observing their faults, deducing the correct devices to overcome these faults, but not simply copying old devices without any practical observation or reflection.

Bièvres, France. M. RATEL.

Testing Polarity of Field Coils

It was with much interest that I read the article on page 955, in the June 16 issue, by Richard Dic Kard on "How To Locate a Reversed Field Coil Without a Compass." No doubt the method used was a good one, but I have never heard of its being tried except in "Physics" classes of high schools. The method that I use in a case of this kind is much simpler and less time-consuming. It is as follows:

Close the shunt-field circuit to the line and then by placing a hammer or nail or any small piece of iron



Method of testing polarity of field coils

from one pole face to another there will be a decided pull as the iron or steel comes into the magnetic field. It will require considerable effort to pull the metal away from the polepieces if the connections are right. If the connections are wrong there will be a small magnetic attraction. The difference between right and wrong polarities can readily be detected even by a novice. A little shop practice on this will also enlighten even the beginner as to the right and wrong polarities. The figure indicates the method of making the test. If the poles are of the polarity indicated in the figure, a strong pull will be obtained on the hammer between *A* and *B* and from *A* to *D*, but the attraction between *B* and *C* and from *C* to *D* will be weak, indicating that pole *C* is of wrong polarity. The remedy is to change the direction of the current through coil *C* by interchanging its connections.

In fifteen years I have never had a motor failure because of wrong field-coil connections and have used a compass less than ten times to check field-coil polarity. The method that is suggested can be used without removing the armature from the frame where mechanical contact can be made with the corners of the polepieces. I have used it with an equal degree of success on series and interpole coils by inserting enough external resistance in the circuit to control the flow of current. H. H. YOUNG.

Okmulgee, Okla.

Questions and Answers

Conducted by

Franklin Van Winkle

Laps and Rivet Pitches of Girth Seams

Why are single-riveted lap seams used for girth seams of horizontal return-tubular boilers with less lapping of the sheets and less pitch of rivets than for the horizontal seams? *W. L. P.*

Without allowance for the assistance rendered by through stays or tubes, the stress per inch length of a girth seam for a given boiler pressure is only one-half as much as the stress per inch length of a longitudinal seam; and when 50 per cent or more of the load that would act on an unstayed solid head of the same diameter as the shell, is relieved by the effect of tubes or through stays, it is allowable to assume that the strength of the circumferential joint needs to be no more than 35 per cent of that required by the longitudinal joints. Single-riveted lap joints are used, because this form of joint presents the least amount of metal to the destructive action of the fire.

To meet the tendency of the outer plate to expand away from the inner one, where the joint passes over the fire, the space between rivets is reduced to the requirement for strength of the joint, and to avoid confusion of rivet sizes where girth seams join the horizontal seams, the same size of rivets is used for both kinds of joints. This usually results in greater ratio of shearing strength of rivets to strength of plate between rivet holes than in the horizontal joints and also in requirement of less pitch of rivet than used for the longitudinal joints.

Resetting Eccentric on D Slide-Valve Engine

How can a slipped eccentric be set on a D slide-valve engine without opening the steam chest? *W. L. C.*

Place the engine on a center and, beginning with the eccentric about 90 deg. ahead of the crank, turn the eccentric around the shaft in the direction that the engine should rotate. If there is a reversing rocker, begin with the eccentric about 90 deg. behind the crank. Alternately set the eccentric and slightly open the throttle valve to find the position of the eccentric for which steam is just admitted to the proper side of the piston, as shown by escape of steam from an indicator cock or cylinder pet-cock connected with the cylinder on the same side of the piston. If the engine cannot be placed on a dead center, to reset the eccentric approximately, first turn the eccentric around the shaft in the running direction until, as shown by the indicator cock or cylinder pet-cock, the valve just admits steam on that end of the cylinder from which part of the stroke has been completed by the piston. Then estimate the angle that the crank is ahead of the dead center and set the eccentric the same number of degrees forward of the position that just admits steam for the proper direction of rotation of the engine.

Of course this adjustment of the eccentric would be only approximate and would not provide for any lead. If it is found that the engine does not run smoothly, it will be necessary to advance the eccentric a little to obtain the necessary lead and compression.

Irregular Division of Draft Between Boilers

We have four horizontal return-tubular boilers set in battery. Each boiler is provided with a 48x16-in. uptake, and all boilers discharge into the same stack connection with inequality of draft. How can the drafts be equalized? *R. D. G.*

All junctions of the uptakes with the main stack connection, as also the junction of the main connection with the stack, should be made with easy bends. To obtain equalization of the draft, each boiler uptake, except the one farthest from the stack, should discharge against a baffle in the main connection, so the gases may be deflected toward the stack before they are brought in contact with gases discharged into the main connection from a boiler farther from the stack. The stronger draft of any boiler will then have a jet-like action tending to increase rather than hinder the discharge of furnace gases of other boilers to the point where the drafts are equalized.

Heat Recoverable from Exhaust of Diesel Engines

How many B.t.u. are in the exhaust gases of two four-stroke-cycle six-cylinder Diesel engines, bore 9½ in., stroke 13 in., r.p.m. 360, average exhaust temperature 450 deg. F., and what theoretical quantity of water in gallons could be heated from 50 to 180 deg. F. per hour by using the exhaust? *G. C. W. G.*

Without definite data as to the fuel consumed, the better method of arriving at a solution of the problem is to calculate the amount of air entering the cylinders per hour and then compute the heat the air carries away with it. Since the oil to air ratio is very small, not greater than 1 to 30, the increased gas mass due to the oil addition may be ignored as may also be the clearance volume, since this is offset by the trapping of burnt gases, etc. The cubic feet of air entering the cylinders of one engine per hour is

$$V = \frac{0.7854 \times D^2}{144} \times \frac{l}{12} \times \frac{\text{r.p.m.}}{2} \times 60 \times N$$

when D = Cylinder diameter in inches = 9.5,
l = Length of stroke = 13 in.,
r.p.m. = Revolutions per minute = 360,
N = Number of cylinders = 6.

Substituting

$$V = \frac{0.7854 \times 9.5 \times 9.5}{144} \times \frac{13}{12} \times \frac{360}{2} \times 60 \times 6 = 34{,}555 \text{ cu.ft.}$$

The weight of this air depends upon its temperature, which will be somewhat above the room temperature,

owing to the absorption of heat, making the temperature about 150 deg. F. Then the weight in pounds would be

$$W = \frac{PV}{RT}$$

where

P = Absolute pressure per square foot = 15×144,
V = Volume in cubic feet = 34,555,
R = Constant = 53.2,
T = Absolute temperature = 460 + 150 = 610,

or

$$W = \frac{15 \times 144 \times 34{,}555}{53.2 \times 610} = \text{practically } 2{,}300 \text{ lb.}$$

The exhaust gases reach the waste-heat boiler at 450 deg. F., and if water is to be heated from 50 to 180 deg. F., each pound of water will absorb 180 — 50 = 130 B.t.u. It is not advisable to reduce the gas temperature below a value at least 50 deg. higher than the water temperature, or 180 + 50 = 230 deg. The gas will then undergo a temperature drop of 450 — 230 = 220 deg. F. The heat removal will take place at a falling pressure and a decreasing volume, so that the specific heat per pound of gas will be somewhere between the specific heat at constant volume and that of constant pressure, and a value of 0.2 B.t.u. per deg. temperature drop is assumed.

The heat transferred to the water will then be

$$H = W(T_1 - T_2)C,$$

where

W = Weight of gases = 2,300 lb.,
T_1 = Exhaust temperature = 450 deg. F.,
T_2 = Final discharge temperature = 230 deg. F.,
C = Specific heat = 0.2,
H = Heat removed;

then

$$H = 2{,}300(450 - 230)0.2 = 101{,}200 \text{ B.t.u.}$$

The weight of water that can be raised from 50 deg. F. to 180 deg. F. by 101,200 B.t.u. per hour would be $W = 101{,}200 \div (180 - 50) = 778$ lb. per hour, and for the two engines the amount would be double this quantity, namely 1,556 lb., or $1{,}556 \div 8.33 = 186$ gal. per hour.

Water Required for Jet Condenser

How many pounds of cooling water are necessary to be supplied to a jet condenser per pound of steam where the barometer is 28 in., vacuum 24 in. and temperature of injection water 60 deg. F.? *W. L. G.*

As may be found from the steam tables, the temperature of steam corresponding to an absolute pressure of 28 — 24 = 4 in. of mercury is 125 deg. F. The discharge temperature must be less than this, as the pressure in the condenser is due not only to the aqueous vapor, but also to air carried over with the condensing water and the condensed steam, making the discharge temperature 10 to 15 deg. lower than that corresponding to the vacuum shown by the gage. Assuming 15 deg. F. lower, the temperature of the discharge water would be 125 — 15 = 110 deg. F.; and taking a constant value of unity for the mean specific heat of water, each pound of cooling water would absorb 110 — 60 = 50 B.t.u. As shown in steam tables, the total heat of a pound of dry saturated steam at the absolute pressure of 4 in. of mercury is 1,114.5 B.t.u. above the temperature of 32 deg. F. Hence to be condensed to the temperature of the cooling water, each pound of steam would have to part with (1,114.5 + 32 — 110) B.t.u. Therefore for each pound of dry saturated steam condensed, the theoretical quantity of cooling water required would be

$$(1{,}114.5 + 32 - 110) \div (110 - 60) = 20.7 \text{ lb.}$$

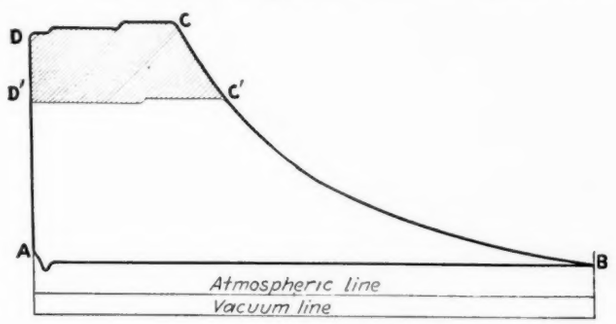
But on account of the inefficient heat absorption in practical installations, about 15 per cent more cooling water would be required, making the quantity about 24 lb. of cooling water per pound of steam condensed.

Power Saved from Reduction of Head Pressure of Ammonia Compressor

At present we are operating our ammonia refrigeration plant under an average head pressure of about 205 lb. gage. How much power would be saved from operating under a head pressure of 175 lb. gage? *G. S.*

To determine the actual saving it would be necessary to take account of the suction pressure. However, it may be stated broadly that a reduction of the discharge pressure will reduce the horsepower input required for driving the compressor.

An indicator diagram taken from a compressor would be something like that shown in the illustration, and if the discharge pressure be 215 lb., the diagram would be similar to the figure *ABCD*. The area of this diagram is proportional to the power required by the compressor. By reducing the discharge pressure to 155 lb. the indicator diagram would be similar to a



Saving of power from reduction of head pressure

ABC'D', and with removal of the area *DCC'D'* the power required per stroke has been decreased proportional to the decrease in the area of the diagram. The percentage of decrease also depends upon the suction pressure.

The following table from *Power's* "Practical Refrigeration," page 22, gives conservative values for horsepower required per ton of refrigeration per 24 hours with various suction and discharge pressures:

Condenser Pressure Lb. Gage	Suction Pressure Lb. Gage					
	5	10	15	20	25	30
145	2.02	1.69	1.40	1.26	1.11	0.99
155	2.11	1.76	1.48	1.38	1.19	1.05
165	2.21	1.85	1.57	1.41	1.25	1.13
175	2.34	1.94	1.65	1.48	1.34	1.18
185	2.48	2.03	1.75	1.57	1.40	1.27
195	2.55	2.14	1.84	1.67	1.48	1.33
205	2.69	2.24	1.91	1.75	1.55	1.40

By reference to the table it is seen that with 15 lb. suction pressure and reducing the discharge pressure from 205 to 175 lb. gage, the reduction of power required would be 1.91 — 1.65 = 0.26 hp. for each one ton of refrigeration duty performed by the compressor in 24 hours, or a saving of $0.26 \times 24 = 6.24$ hp.-hr. per ton.

A new slant on things observed in and out of the power plant

What Happens and Why?

The Slip of a Pump

WORK is expended wherever a force acts on a moving point, assuming that all or part of the motion of the point is in the direction of the force. If the point of application of the force "slips," the work actually accomplished in moving the body is less than that expended. Since this principle has a direct application to the slip of pumps, it is worth further study.

Figs. 1 and 2 clearly illustrate the effect of slip in lifting a weight. It is assumed (Fig. 1) that a 1,000-lb. weight is being raised by a rope passing over a pulley and that the rope is securely fastened to the weight, so that there is no slip. Then if ten feet of rope are pulled over the pulley the weight will rise ten feet. Neglecting pulley friction, the tension in the rope is 1,000 lb. at all points. Therefore the work expended on the rope = 1,000 × 10 = 10,000 ft.-lb. = work received by weight from rope.

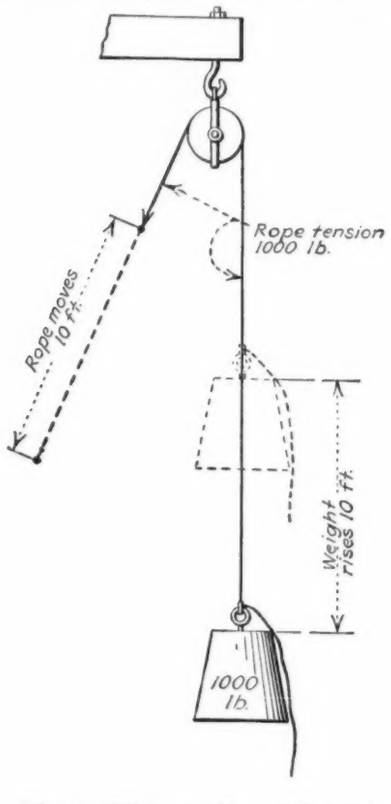


Fig. 1—With no slip, work received equals work expended

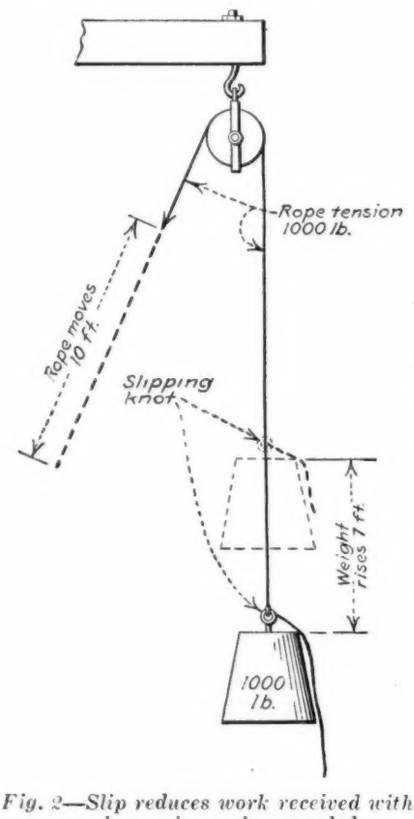


Fig. 2—Slip reduces work received with no change in work expended

Now let us consider the effect of slip. Fig. 2 is the same as Fig. 1 except that the rope is attached to the weight by a slipping knot. A steady slip will not affect the tension in the rope, which will be 1,000 lb. as before. Then if 10 ft. of rope are pulled over the pulley, the work expended will be 10 × 1,000 = 10,000 ft.-lb. Owing to slip the weight rises, let us say, only 7 ft., so the work received by the weight is 7 × 1,000 = 7,000 ft.-lb. The loss of work is then $\frac{3}{10}$, or 30 per cent, which is the same as the percentage of slip.

The analogy with a pump is almost perfect. The piston of a pump exerts a certain force through the length of the stroke in lifting water. If there are no leaks past the piston, through valves, stuffing boxes or elsewhere, this work would deliver against the discharge pressure a "cylinder" of water having a length equal to the stroke and a diameter equal to the bore of the pump cylinder.

The work expended by the piston equals the total force on the piston multiplied by the stroke in feet. The work received by the water per stroke equals the weight actually delivered multiplied by the head against which it is delivered. That these two are theoretically the same, neglecting slip as well as pressure drop through valves and connections, is illustrated by Fig. 3.

If the pump "slips," it does not change the force on the piston, or the work expended, but the work delivered is cut down in proportion to the slip. Thus a slip of 30 per cent means that 30 per cent of the power supplied to the pump piston is unnecessarily wasted.

Evidently, it is a matter of considerable importance that the slip of pumps be kept within reasonable limits. To do this as a matter of operating routine, some simple method must be provided for measuring, or at least detecting, excessive slip. Where the water handled by the pump passes through a meter or other measuring device, this can be done by placing a stroke counter on the pump. Occasional comparison of counter and water-meter readings will permit detection of slip.

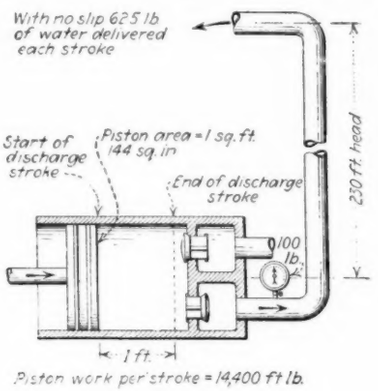


Fig. 3—Diagram of perfect pump expending and delivering 14,400 ft.-lb. per delivery stroke

For example, suppose it is a duplex, double-acting pump of 6-in. bore and 8-in. stroke. From the formula of Fig. 4 the cubic feet delivered per single stroke of one cylinder (without slip) will be 0.000455 × 36 × 8 = 0.131 cu.ft. or 4 × 0.131 = 0.524 cu.ft. for double stroke of two cylinders. Suppose a comparison of counter and meter readings shows a delivery of 0.46 cu.ft. per double stroke. Then the percentage slip is (0.524 — 0.46) ÷ 0.524 = 0.064 ÷ 0.524 = 0.122 = 12.2 per cent.

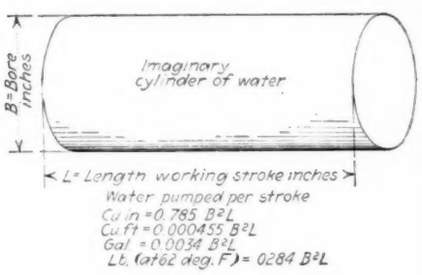

B = Bore inches
Imaginary
cylinder of water
L = Length working stroke inches
Water pumped per stroke
Cu. in = 0.785 B²L
Cu. ft = 0.000455 B²L
Gal. = 0.0034 B²L
Lb. (at 62 deg. F) = 0.284 B²L

Fig. 4—Formulas for figuring theoretical pump delivery per stroke

New and Improved Equipment

McNeill Liquid Level Gage

In the boiler plant the present trend toward higher steam pressures and temperatures has created a demand for water-level indicators that will withstand the more severe service and at the same time have the visibility desirable in a gage of this character. With the increase in the use of large boiler units, the latter problem has been intensified owing to the great heights involved with the gage located at the water level in the boiler.

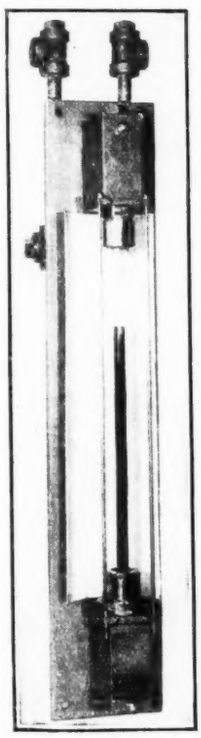


Fig. 1—McNeill water level indicator

A solution of these difficulties is now being offered in the new McNeill liquid level gage of the Boiler Room Improvement Co., 549 West Washington St., Chicago. The new gage will indicate the level of liquids at a point remote from and below the actual level and is particularly adaptable to boilers. It is connected top and bottom to the usual water column and located in the horizontal line of vision of the operator near the boiler-room floor. Neither steam nor hot water from the boiler reaches the glass, so that it is not subject to the severe temperature strains that result in breakage nor to the eroding action of the steam. The action of the gage is that of a mercury U-tube indicating the differential head between the points of connection, or actually the water level in synchronism with the usual water column. The movement of the mercury is multiplied by the introduction of a lighter medium in the glass in the form of a dark liquid, so that any desired multiple or reduction of the actual water movement may be obtained in a glass of convenient length. With the glass backed by white concave reflectors and the line of vision horizontal, exceptional visibility is obtained. This is evident from Fig. 1, which shows a gage taken before it was installed in a plant operating at 600 lb. boiler pressure.

Reference to the diagrammatic sketch, Fig. 2, will give a better understanding of the actual construction and the connections of the gage. The indicator consists of elements, top and bottom, made from cold-rolled-steel blocks chambered out as indicated. They are mounted on a steel plate and the outer chambers are connected with each other by an ordinary tubular gage glass having suitable glands and stuffing boxes. The inner chamber of each element is connected through ½-in. piping to the upper and lower limits, respectively, of the variable column of water to be measured. The lower element is a U-tube mercury container which is proportioned to give the desired travel of the indicating liquid in the glass with variation in the head. The upper element, an inverted U-tube having the same dimensions as the lower element, is used as an oil trap. A clear transparent oil separates the condensation in the inner chamber of the upper element and the colored liquid in the glass. This eliminates discoloration of the glass, and as in both legs the oil rests on a column of water or its equivalent in specific gravity, the line of demarkation between the liquids is maintained.

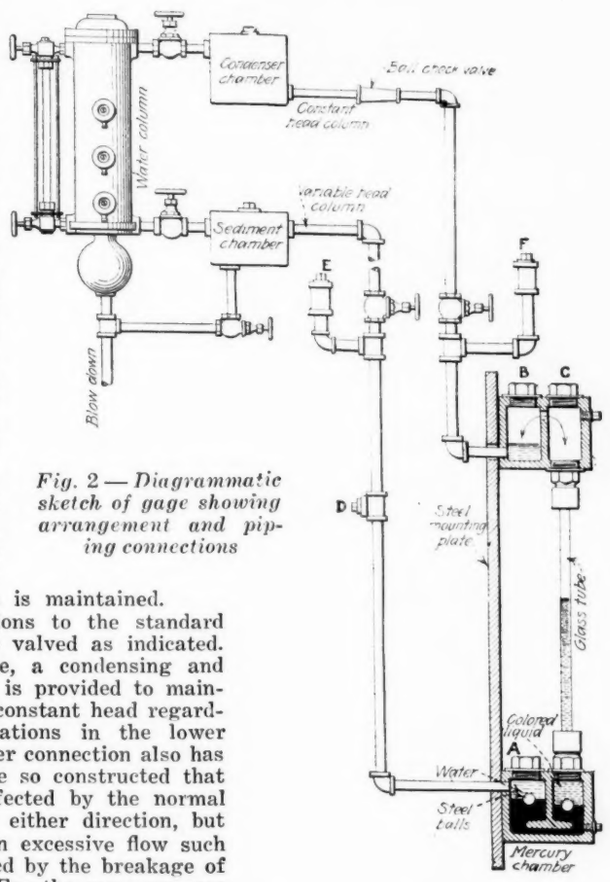


Fig. 2 — Diagrammatic sketch of gage showing arrangement and piping connections

Piping connections to the standard water column are valved as indicated. In the upper line, a condensing and capacity chamber is provided to maintain a column of constant head regardless of the variations in the lower column. The upper connection also has a ball check valve so constructed that it will not be affected by the normal flow of water in either direction, but will close from an excessive flow such as would be caused by the breakage of the gage glass. For the same purpose steel balls float on the surface of the mercury in the lower element of gage.

In the lower or variable-head column to the gage, a sediment chamber of practically the same proportions as the condenser is provided. It is connected so that the water column may be blown through it, so that any collection of sediment may be removed. Plugs *A*, *B*, *C*, *D*, *E* and *F* are provided to give access to the gage and to permit the introduction of the different liquids in proper amount.

To test the gage for accuracy, it is necessary only to blow down the boiler water column and notice that the colored liquid goes down in the glass just slightly below the lower gland nut, indicating that there is no water in the upper glass. When the blow-down is shut off, the colored liquid will return to the correct indication of the water level as quickly as the water itself does in the upper glass.

Liberty Valve Operator

The illustrations show a motor-driven valve operator brought out during the last year by the Liberty Electric Corp., Stamford, Conn., which embodies certain special features. These include the use of a magnetic driving clutch and an emergency safety clutch in addition to the limit switch for cutting off the current at the two extremes of travel.

Referring to Fig. 2, the motor is connected directly to the shaft *A*. This drives the worm *B* to which is attached the magnetic clutch *C*, the combined unit being free to revolve on the drive shaft *D*. A soft iron armature *E* forming the other half of the driving clutch, is connected to the drive shaft through the safety clutch *F* and is arranged to slide forward and backward on the shaft for a short distance.

To preclude the possibility of excessive force being applied to the stem owing to obstruction getting below the disk when closing or from other causes, the safety clutch *F* has been provided.

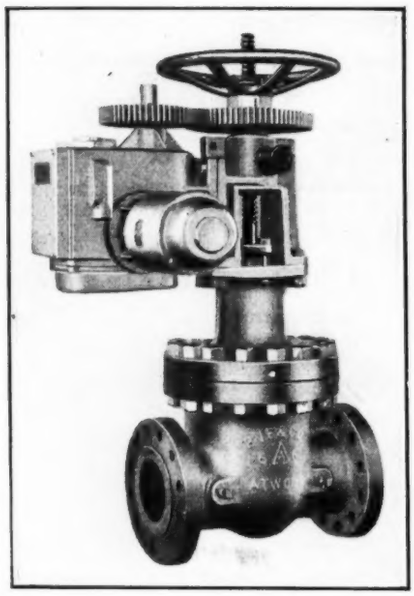


Fig. 1—Operator attached to valve

This clutch is of the multiple-disk, dry-plate type, the plates being alternately brass and steel annealed. The clutch is adjustable over wide limits by means of the locknuts *G*.

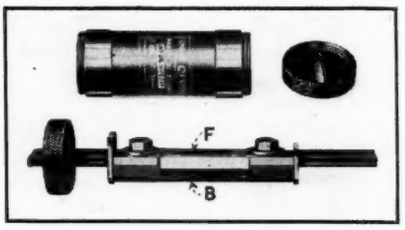
Control of the current to the motor and magnetic clutch *C* is effected by means of contacts on the time shaft *H*, which is driven through a train of gears from the main drive shaft *D*. In operation, as the nut *J* travels toward the switch *K*, it forces the sleeves *L* back. This sleeve carries the cam *M*, the face of which is held against a finger *N*, by the tension of the coil spring *O*. As this cam is forced back, the finger disengages from the face of the cam, allowing the spring *O* to release. The spring tension turns the drum *K* on which the electrical contacts are inserted, thereby making or breaking the circuit for the operation of the unit. The tension of the spring at the time of release is sufficient to open the contacts on the drum *K* without arcing and therefore obviate the necessity of relays for disconnecting the motor. Upon reversal of the direction of travel of the time shaft, the cam once more engages with the arm *N* and resets the contact drum *K*. The current to the motor and the magnetizing coil in the clutch *C* is controlled from the same contacts so that the current is applied to each or cut off at the same instant.

In operation, as the motor starts up, the armature *E* is drawn against the face of the magnet *C* and a certain amount of slip takes place until the dogs *P* engage with slots in the face of the armature *E*. When the clutch is properly engaged, the stem of the valve is made to revolve through the safety clutch *F* as previously described. The edges of the dogs are slightly beveled and this, assisted by coil springs (not shown), causes the clutch to release the instant current is cut off.

The slip that occurs previous to the engagement of the clutch allows the motor to turn several revolutions and pick up speed before the dogs actually engage. Likewise, upon release of the clutch the motor is permitted to float to stop. The units are equipped with direct- or alternating-current motors to suit the various installation requirements.

Union Renewable Fuses Simplified in Construction

Recently, the Chicago Fuse Manufacturing Co., Chicago, Ill., brought out an improved line of its knife-blade type renewable fuses. The figure shows the details of design and construction. When the fuse is taken apart for renewal of the fusible element, there are only three loose parts: The fiber case



Fuse disassembled showing details of construction

to which the threaded brass ends are attached; the knife blades which are connected by a rigid fiber bar *B*—and to which the fusible element *F* is bolted; and one of the screw caps which hold the knife-blade member in position. The chief improvement in the design is the supporting of the two knife terminals on the fiber bar *B*. In the old design the knife terminals were attached by the fuse element only.

All that is necessary to disassemble the fuse is to unscrew the two caps and then slip out the entire knife-blade member after one end of it has been shifted slightly to get it out of its locked position. One of the caps can be removed, but the other is held on the knife blade by two nibs. These new fuses are made in all standard ratings from 65 to 600 amperes, 250 or 600 volts.

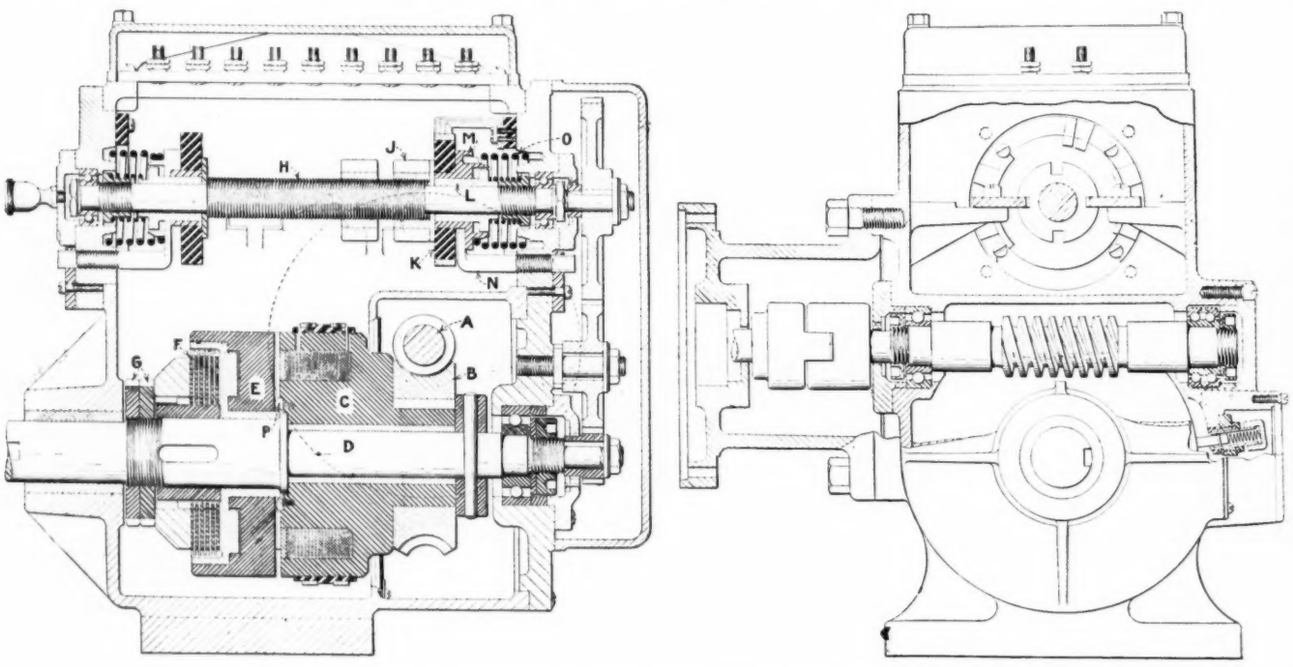


Fig. 2—The motor is connected to valve stem through magnetic and safety clutch

American Petroleum Institute Submits Report to Federal Oil Commission

No Oil Shortage Expected for Years—26,000,000,000 Barrels Still Remain in Proved Areas—1,100,000,000 Acres Not Fully Explored Have Oil Indications

THE American Petroleum Institute, has just published a report covering the future supply of petroleum in the United States as announced in *Power*, July 21. The report, which has been submitted to the Federal Oil Conservation Board at Washington, is reassuring. It says that the nation is assured of a supply of motor fuel and lubricants sufficient to meet the needs of national defense and for essential uses beyond the time when science will limit the demand by developing more efficient uses of, or substitutes for, oil, or will displace its uses as a source of power by harnessing a natural energy.

The survey, which is published by the McGraw-Hill Book Co., Inc., 398 Seventh Ave., New York City, estimates the petroleum recoverable from existing fields at 5,300,000,000 bbl. and that after pumping and flowing cease there will remain in the area now producing and proved 26,000,000,000 bbl. of oil, a considerable portion of which can be recovered by improved and known processes.

Summary of Conclusions

The following is the committee's summary of conclusions:

"There is no imminent danger of the exhaustion of the petroleum reserves of the United States.

"It is reasonable to assume that a sufficient supply of oil will be available for national defense and for essential uses in the United States beyond the time when science will limit the demand by developing more efficient use of, or substitutes for, oil, or will displace its use as a source of power by harnessing a natural energy.

"Current supply and demand cannot stay in balance, since the amount of both supply and demand are constantly changing. Generally, current supply will exceed or be less than current demand, creating surplus or shortage; either condition will be reflected in price, but price will in time correct either condition.

"Petroleum recoverable by present methods of flowing and pumping from existing wells and acreage thus proven consists of five billion, three hundred million (5,300,000,000) barrels of crude oil.

"It is estimated that after pumping and flowing there will remain in the area now producing and proved twenty-six billion (26,000,000,000) barrels of crude oil, a considerable portion of which can be recovered by improved and known processes such as flooding with water, the introduction of air and gas pressure and mining, when price justifies.

"Improved methods of deep drilling below oil sands now producing will disclose in many areas deposits not hitherto available, which will be tantamount to the discovery of new fields. Improved methods of producing have been perfected which will make possible recovery of oil from these lower levels. The limit of deep drilling has not been reached.

"The major oil reserves of the United States lie in some one billion, one hundred million (1,100,000,000) acres of lands underlain by sedimentary rocks and not fully explored, in which geology indicates oil is possible. With extended search new supplies will be found therein.

"The Nation has an additional reserve in the vast deposits of oil shale, coal and lignites from all of which liquid fuels and lubricants may be extracted if and when the cost of recovery is justified by the price of these products. These deposits are so huge that they promise, under conservative estimates, an almost unlimited supply.

"While this report is confined to the petroleum supply and demand within the continental United States the importance of imports cannot be ignored. Countries to the south are known to have large petroleum resources, for the output of which the United States is a natural market and the supply therefrom must inevitably have its influence on the consumption of American reserves.

"The availability of future petroleum supplies from the vast area of land mentioned above depends upon adequate incentives to the exploration, which in the past has given the Nation a sufficient supply of petroleum, in peace and in war, throughout the history of the oil industry, from its inception in 1859.

"There must be:

"(a) Security in the ownership of oil lands and of the right to lease.

"(b) Conditions of exploration and development by owners or lessees permitting exercise of initiative, liberty of action, the play of competition, and the free operation of the law of supply and demand.

"(c) Prices that will provide a return to producers, refiners and distributors commensurate to the risks involved and the capital invested.

"The supply of petroleum will be made to go further through more efficient utilization. Automotive experts state that the mileage of the motor car per gallon of gasoline may be doubled through structural mechanical changes, when price justifies such changes. Improved mechanics will also result in smaller consumption of lubricants.

"Through improved methods, principally the process known as 'cracking' the refining branch of the industry has already increased the yield of gasoline, now the major product of petroleum. Through further improvements and extensions the supply of gasoline will be augumented still further by the 'cracking' of fuel oil. In consequence the supply of fuel oil will be correspondingly diminished, thus eventually removing fuel oil from competition with coal.

"Waste in the production, transportation, refining and distribution of petroleum and its products is negligible."

"The discovery of crude oil—which is the beginning of the oil industry and on which so much depends—is not an exact art," the report goes on. "Oil is hidden—the industry is essentially a 'finding' industry, attended with great uncertainties in the search. The future supply of crude oil cannot be blocked out and drawn upon as needed as in the case of oil shales, coal and lignites, from which liquid fuel can be extracted, and of many other minerals. Favorable looking lands become oil fields when the drill has revealed the presence of oil, and only then. Hence predictions of future supply of crude oil are necessarily conjectural. Speculative, also, perhaps to a greater degree, must be estimates of future demand, depending as they do upon conditions which, with the advance of science and invention, may undergo unforeseen and radical changes. Conclusions of the committee are based on the best information obtainable, within and without the industry."

Water Power Resources Bill Will Be Introduced

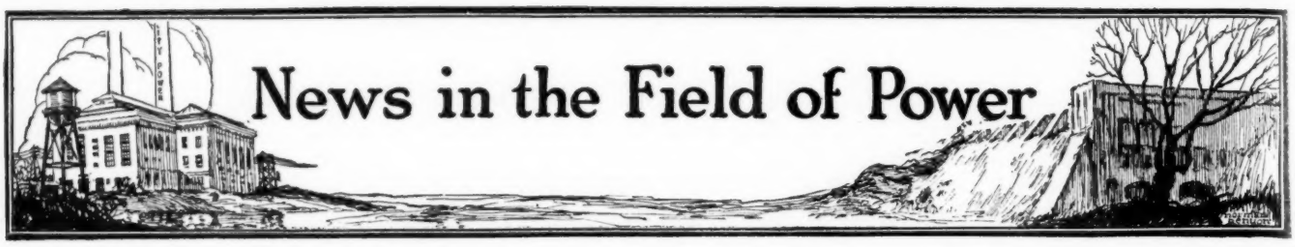
A bill providing for "an inventory of the water resources of the United States" will be introduced at the forthcoming session of Congress. The proposed legislation authorizes the Director of the Geological Survey to make this inventory for use in setting up a comprehensive plan "for developing both surface and ground waters for domestic and industrial supplies, irrigation, navigation, power and other uses and for the conservation and control of flood water."

An appropriation of $400,000 is sought for the first year's work and $500,000 for each year for nineteen years thereafter.

The purpose of the bill is to expand the work of the water resources division of the Geological Survey and vest in that agency, among other things, the authority to make the general survey of the country's streams.

An ineffectual effort was made at the last session to secure legislation that would have enabled the Federal Power Commission to make such a survey.

The Power Commission and the Corps of Engineers, however, were directed to report to Congress the cost of such a survey.



New Power Plants in Colombia

The municipality of Ibague in Colombia is planning to install an electric-light plant, and an electric plant has recently been installed in Cartagena, according to a recent report from Commercial Attaché William Boaz, Bogota, in *Commerce Reports*.

Salt Valley Water Users' Plan Hydro Development

Annual development of 43,000,000 kw.-hr. of hydro-electric energy, worth $350,000, is projected in plans being made by the Salt River Valley Water Users' Association. At a cost of $410,000, advanced by the Central Arizona Light & Power Co. of Phoenix, an additional power-generation plant is being erected below the Mormon Flat dam of the association on Salt River, a dam originally planned only for water distribution.

The local company is to be repaid in current, at a price of 8¼ mills per kilowatt-hour, together with interest at 6 per cent. The Mormon Flat plant is to be operating by April 1.

Impounding Water at Muscle Shoals Dam Discontinued

Impounding of water at the Muscle Shoals dam was discontinued August 10 so that the full flow of the Tennessee River may be available for navigation uses. The stage of the Tennessee is lower than at any other time on record. Navigation of that stream is seasonal and no great loss results from its interruption, but vigorous complaints have been registered by those concerned with operations on the Mississippi River. Difficulties are being experienced in navigating that river just below Cairo. Gen. T. Q. Ashburn, the head of the Inland Waterway Service, contends that the diversion at Muscle Shoals is partially responsible for his troubles. Gen. Edgar Jadwin, the acting Chief of Engineers, is convinced that any water which has been used to build up the pool at the Wilson dam has not affected navigation appreciably in the Mississippi, but to prevent any feeling that this is responsible for the difficulties now being experienced, he will withdraw no further water until higher stages are available.

Gen. Jadwin points out that the Wilson dam has been built at large costs for the improvement of navigation and for the development of the power resources of the river. Loss of revenue from the sale of power, alone, approximates $1,000 per day. The extent to which the tests of the generators at Muscle Shoals will be delayed will depend entirely on rainfall.

It also is of great importance to the southeastern states to make this power available at the earliest possible date. The demand for power in the southeastern states never has been as great. Because of the dry season 82 per cent of the June output was developed at steam plants. The steam plant which is leased from the government at Muscle Shoals has been operated at capacity for nearly two months.

The pool at Muscle Shoals still lacks twelve feet of being at the operating level.

C. H. Berry Joins Power Editorial Staff

Power announces with pleasure the addition to its staff of C. Harold Berry as Associate Editor. Mr. Berry has had a training and experience that will particularly fit him for the duties and opportunities of his new position.

C. Harold Berry

Graduated from Pratt Institute in 1909, he entered Cornell University as a sophomore and graduated with the degree of M. E. in 1912. The following year he began five years of teaching at Cornell, three years as instructor and two as assistant professor of heat power engineering, during which period he took a graduate course and received the degree of M.M.E. in 1916. Most of his summer vacations were spent in the Research Department of the Detroit Edison Co., and shortly after the war he accepted a permanent position with that company as engineer in its research and production departments. He became assistant to J. W. Parker, chief engineer of the company, and later was made technical engineer of power plants, responsible for testing and operating economy in the four steam generating stations.

Mr. Berry has been active in the A.S.M.E. as a member of the Power Tests Code Committee, and of the Subcommittee on Steam Turbines. He was also chairman of the Executive Committee of the Detroit Section, A.S.M.E., and has been actively identified with the Associated Technical Societies of Detroit.

He begins his work with *Power* on September first.

Lower Rate Ordered for Boston Electric Light

During the first week of August the Massachusetts Department of Public Utilities reduced the maximum price of electricity on the system of the Edison Electric Illuminating Co. of Boston to 8.5c. per kw.-hr., closing a case that has been in the hands of the state regulative authorities in one form or another for the greater part of a decade.

Four petitions were before the board, three being complaints against prices brought by consumers (including one by the City of Boston) and one from the company, which sought to obtain higher rates from certain large consumers. The city and the company recently reached an agreement in the matter of street-lighting rates, and at that time the city and company agreed to settle the former's petition concerning rates if the company would reduce the residence "A" rate to 8.5 cents.

Samuel Insull Warns Against Speculation in Utilities

Samuel Insull, chairman of the Middle West Utilities Co., Chicago, Ill., in replying to the rumors of fabulous earnings of the Middle West Company, said:

"Most of the speculation has been in the shares of the holding companies. There is little or no speculation in the securities of the local operating companies, and, after all, the great volume of capital in the utilities, both gas and electric, is invested in the operating companies. My note or warning refers more to the holding companies' security prices than to the operating companies' prices.

"Profits of utility enterprises have been more stable than those of manufacturing concerns, but no business which is subject to regulation by commission can make more than a reasonable profit. There is an absurd tendency in the public mind to confuse public utilities with industrial corporations.

"I want to see public-utility stocks sell on a fair investment basis. There are no inventions in sight at the present time that would tend to reduce utility costs. A given number of dol-

lars invested in the utility business with close management will afford a good return, but can never justify the foolish predictions made recently by those interested in speculation."

Grand Falls Power Project Contract Let

Contract for the dam and power house for the hydro-electric development at Grand Falls, New Brunswick, has been let to the Dominion Construction Co. of Montreal for $1,546,556. The contract was let by the New Brunswick Electric Power Commision. In all, eight bids were submitted, the largest being $1,819,041, or $234,000 below the engineer's estimate of $2,033,000.

Charlotte, N. C., To Have Lower Power Rates

Reduction in rates for electric current ranging from 3.1c. per kilowatt-hour for industrial power to 1 cent for lights is announced by the Southern Public Utilities Co., a subsidiary of the Southern Power Co., which supplies power and light to Charlotte, N. C., and Greenville, S. C.

Officials of the company say that it will effect a saving or more than $200,000 a year to the consumers. These reductions affect virtually all customers of the company.

Power Machinery Exports to Venezuela Increase

Exports of power-generating machinery from the United States to Venezuela gained from $211,992 in 1923 to over $350,000 in 1924, according to *Commerce Reports*. Machinery items in this classification showing the greatest increase in exports are stationary steam engines, except turbines, steam boilers (a gain of nearly 100 per cent) and stationary gasoline engines. Exports of boiler accessories and parts, such as injectors, gages, safety valves, etc., increased from approximately $20,000 in 1923 to over $43,000 in 1924.

The following table gives increases in detail:

UNITED STATES EXPORTS OF POWER-GENERATING MACHINERY, EXCEPT ELECTRIC, TO VENEZUELA

Class	1922	1923	1924
Steam engines:			
Stationary, except turbines	$4,159	$13,700	$28,596
Marine, except turbines	5,461	.....	184
Mechanical-drive turbines	15,000	.....	.....
Other engine accessories and parts	30,879	29,980	26,202
Boilers	38,507	86,859	167,258
Condensers, heaters, and accessories	594	135	2,525
Injectors, gages, safety valves, and other boiler accessories and parts	26,807	20,882	43,700
Internal-combustion engines:			
Stationary and portable Diesel and semi-Diesel	455	6,080	640
Other stationary and portable over 10 hp.	13,068	15,355	40,933
Marine Diesel and semi-Diesel	1,775	.....	.....
Other marine, except detachable	11,166	14,014	4,982
Accessories and parts	12,410	17,438	29,590
Waterwheels and water turbines:			
Under 500 hp.	45,682	5,764	8,121
500 hp. and over	.....	1,785	.....
Total	205,963	211,992	352,731

New Des Moines Plant Being Tested

The first section of the new Des Moines (Iowa) generating station is being tested out and will be placed in operation during this month. This new generating plant, which was built by the Iowa Power & Light Co., a subsidiary of the Illinois Power & Light Corp. and described briefly in *Power*, Jan. 6, 1925, was required to carry the rapidly increasing electric load of the Des Moines district, which reached a peak of over 24,000 kw. last year. Prior to the completion of this station the entire load was carried by the company's Center Street plant, which will now be retained as a reserve source of power. Owing to the limited space at the Center Street plant, which is in the heart of Des Moines, it was necessary to move out of the city, and a site on the Des Moines River at Ball's Ford, seven miles below the city, was chosen.

The new station is being developed on the unit plan. The first unit contains a 25,000-kva. and a 35,300-kva. turbo-generator set. Three additional 35,300-kva. turbines will be added in the future, making an ultimate plant capacity of 166,000 kva. While the design embodies no unusual features, it is believed that excellent economy will be obtained in operation. The plant is stoker-fired.

In addition to supplying Des Moines, the new station will serve forty-four other communities in central Iowa. The design and construction of the new Des Moines station was carried out entirely by the company's engineers through the Illinois Power & Light Corp. Only fifteen months passed from the time ground was first broken until the station was ready for operation.

Use Money for Cement Instead of Lawsuits, Says Hoover

MORE water must be made available to keep the West out of a welter of litigation which may retard its development for a quarter of a century. Water rights are so indescribably complex that the only escape from conflict is the providing of water enough for all. This can be done if money is spent on cement and not on lawsuits.

These are some of the conclusions of Commerce Secretary Hoover based on his intensive first-hand observations while on his recent Western trip. He finds that from seven to fifteen agencies have a hand in each project involving the use of water. These activities must be co-ordinated, he declares.

Everyone knows that the need of the West is water and that lawsuits do not produce water, so the obvious thing to do, Secretary Hoover declares, is to concentrate brain, brawn and money on the contruction of dams and reservoirs.

July Sales of Mechanical Stokers Increase

There were sold during July, 147 mechanical stokers which were installed under 30 fire-tube boilers having 50,750 sq.ft. of heating surface and 117 water-tube boilers of 536,440 sq.ft. of heating surface. This information was obtained by the Department of Commerce from reports received from 13 establishments.

Ontario Hydro Commission Reports Power Shortage

In the annual report of the Ontario Hydro-Electric Power Commission, issued recently, attention is drawn to the fact that the commission has completed a successful year, reporting that the revenue obtained from consumers has been more than sufficient to meet the full cost of generating and transmitting power as well as providing for all operating expenses and the fixed charges of the municipal utility equipments. The report shows that, after meeting all these charges, the commission has a net surplus on the year's operations of $725,708.

While there has been a general industrial depression, there has still been an increasing growth in the demand for power on nearly all systems, and on several systems the commission has reached the limit of the capacity of the existing generating plants.

With regard to a power shortage the report says:

"During the past year special efforts have been made by the provincial government, the municipalities and the Hydro-Electric Power Commission to secure permission to commence construction of the power development work in the international portion of the St. Lawrence River. Delay in securing the permission sought must result in accentuating the power shortage that is rapidly materializing."

Concerning the expected increased demand, the report says: "The full capacity of the commission's generating plants is not sufficient to provide for any abnormal increase in the demand for power, such as may follow an industrial revival, and is inadequate to meet the needs of power consumers during a year of normal growth. Further sources of power must be provided during the coming year if restrictions on the supply to consumers are to be avoided."

A revision of rates in the rural power districts served by the cimmission is announced. The report states that, "Based on its experience on the operation of rural power districts, the commission has found it necessary in many of these districts to adjust the service charge and consumption rates, in order that the service supplied to the consumers may be as nearly as possible on a cost basis. In sixty-five of the rural power districts served it has been found necessary to make a reduction of from 5 to 40 per cent in the service charge and in fifty-seven of the rural power districts a reduction of from 5 to 25 per cent in the consumption charges."

Associated Gas and Electric Buys The Pennsylvania Electric Corporation for $175,000,000

Savings of $1,000,000 a Year in Cost of Generating Power Estimated

ONE OF THE LARGEST direct transfers of power properties since the power interconnection movement got its first real impetus several years ago has been arranged between the Associated Gas & Electric Co., a New York incorporation, and the Pennsylvania Electric Corp. controlled by H. D. Walbridge and associates, and known as the Penn Public System.

With the Associated properties in western New York, and the Pennsylvania Electric properties in western Pennsylvania and Maryland the consolidation brings together public utility groups having aggregate assets of more than $175,000,000, and provides a chain of power properties connected all the way from the zone of Niagara Falls to and including the western part of Maryland through Pennsylvania southward.

This deal, which is understood to involve a cash transaction of about $20,000,000 for common and preferred stock of the Pennsylvania Electric Corp., represents the largest yet undertaken by the Associated Gas & Electric Co., and is one of the most extensive power merger undertakings ever arranged by a New York company.

The effect is to create a new system of electric and gas properties serving an estimated population of 2,000,000 or more, and having 300,000 consumers in 930 communities of New York, Massachusetts, Connecticut, Vermont, New Hampshire, Maine, Kentucky, Tennessee, Pennsylvania, Maryland and the Philippine Islands. Hydro-electric and steam stations of both companies have over 325,000 hp., installed capacity, and 2,500 miles of high-tension transmission lines.

The Penn Public System

The Pennsylvania Electric Corp. is one of the most compact and highly developed electric properties in the East. Its Penn Public System serves an area one-sixth of the State of Pennsylvania, extending the full width of the state from Erie, on the north, down through Meadville, Warren, Clarion, Du Bois, Clearfield, Phillipsburg, Indiana, Johnstown, to Somerset on the south and over the border into Maryland, where one of the large hydro-electric stations is located. This system serves more than 350 communities with a total estimated population of 875,000.

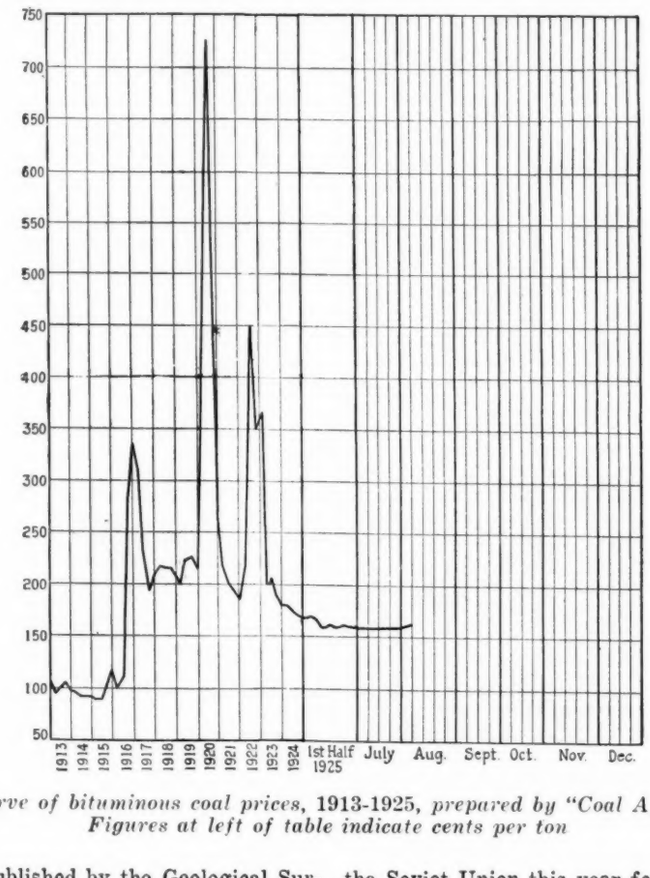
The discontinuance of the production of large quantities of energy in the smaller plants and the increased production of the large generating stations which are now being brought about, will effect, it is estimated, a saving of $1,000,000 a year in the cost of generating power.

Features of the property acquired include a system of large dams and storage reservoirs, making possible a uniform power supply throughout the year. The company through a subsidiary, owns five coal mines containing over 16,000,000 tons of coal and has under lease 4,000,000 additional tons. From the viewpoint of power economics, therefore, it is believed that the tie-up with the Associated properties contiguous to it is an operation of major importance in the country-wide power interconnection scheme which has found favor with the national authorities.

Soft Coal Cheaper in 1925 Than Since 1916

Coal Age publishes each week a diagram that shows the relative prices on fourteen coals, representative of nearly 90 per cent of the bituminous output of the United States, weighted first with respect to the proportions each of slack, prepared and run-of-mine normally shipped, and, second, with respect to the tonnage of each normally produced. The average thus obtained was compared with the average for the twelve months ended June, 1914, as 100, after the manner adopted in the report on "Prices of Coal and Coke; 1913-1918," published by the Geological Survey and the War Industries Board.

The current diagram which is reproduced here shows that during the first seven months of 1925 the price of bituminous coal has been lower than it has been at any time since the first half of 1916.



Curve of bituminous coal prices, 1913-1925, prepared by "Coal Age." Figures at left of table indicate cents per ton

Damage to Hetch Hetchy Penstocks was $50,000

Damage to the hydro-electric plant of the City of San Francisco, the Hetch Hetchy plant on Moccasin Creek, caused by the bursting of two penstocks, reported in *Power*, July 14, page 75, resulted in damage amounting to $50,000.

Soviet Union Buying Machinery

Russian purchases of machinery in the United States during the first six months of the calendar year 1925 were 42 per cent greater than during the entire year 1924, according to figures compiled by the Russian Information Bureau in Washington, D. C.

Virtually all the purchases were made through the Amtorg Trading Corp. of New York. In discussing the figures, Isaiah J. Hoorgin, chairman of the board of Amtorg, said:

"Hitherto the purchases of machinery made here were largely of replacement machinery and parts. This year they are mostly of basic machinery. This fact is an evidence of the rapid expansion of industry in the Soviet Union, with the building of new factories in the textile, metallurgical, electrical and other lines. The excellent harvest in the Soviet Union this year foreshadows a further expansion of the machine-buying business for Russian account."

Italian Electric Power Industry Status

A rapid increase in the capacity of power installation in Italy has been going on since the war; at the end of 1924 the total installed capacity was nearly double that of 1918. A corresponding increase has taken place in consumption, and while the yearly load factor in 1924 was slightly below that of 1918, it was considerably higher than in 1908, and shows an improvement as compared with 1920 and 1922. As steam plants represent about 20 per cent of the total capacity and operate on the average for only about 600 hours a year, the load factor for the hydro-electric plants reaches approximately 40 per cent, according to *Commerce Reports.*

Development of Electric Power

The growth in capacity of plants is shown in the following table:

Developments in Italian electrical power plants

	Capacity of Existing Plants Kilowatts	Yearly Load Factor Per Cent
1908	422,000	23.5
1918	1,240,000	32.3
1920	1,385,000	29.0
1922	1,594,000	30.0
1924	2,107,000	30.4

Uses of Electric Current in Italy

The following approximations indicate the uses to which the current is put:

	Per Cent
Lighting	9.0
Traction	7.3
Electrochemical and electromechanical industries	11.3
Textile Industries	13.0
Milling and foodstuffs	8.0
Mechanical industries and other uses	51.4
	100.0

Hydro-electric Installations Supply Greatest Power

In 1923 over 95 per cent of the total kilowatt-hours generated in Italy were derived from hydro-electric installations. Steam plants occupy a position that is relatively more important now than in 1923, although in many instances these plants are used merely as a reserve. In the southern provinces and the islands, where the available water power is limited, the production of the steam plants represents over one-fourth of the total, but in the northern provinces their output is not greater than 3 per cent. The increased output during recent years, however, has been largely supplied by hydro-electric plants. All together there are 122 steam plants and 341 water-power plants. Of the total installed capacity 20 per cent is in steam plants.

Increase in Consumption

Exact statistics covering the consumption of electric energy in Italy are not available, though careful estimates indicate that in 1924 about 6,400,000,000 kw.-hr. was generated. From 1920 to 1924 there has been an average annual increase in consumption for lighting of 15.2 per cent and of 13.2 per cent in consumption for other uses. In 1922-23, as compared with 1921-22, there was an increase of 27 per cent in the consumption of electricity for uses other than lighting, and in 1923-24, as compared with 1922-23, an increase of 15 per cent.

Columbia River Has Large Power Possibilities

The engineers of the Geological Survey have made several preliminary estimates of the water-power resources of Columbia River proper. The latest estimate, which is summarized below, takes into account all factors that are likely to influence the flow in the future and indicates that about one-seventh of the potential water power in the United States is to be found along Columbia River, exclusive of the very large power resources on its tributaries.

SUMMARY OF POTENTIAL POWER ALONG COLUMBIA RIVER FROM THE INTERNATIONAL BOUNDARY TO ITS MOUTH

(Horsepower at 70 per cent efficiency.)

Sites and Stretches	90 Per Cent of the Time	50 Per Cent of the Time
At nine dam sites:		
Natural flow	2,726,000	5,427,000
Regulated flow	3,297,000	5,480,000
In stretches within which information is inadequate for determining sites:		
Natural flow	1,228,000	2,415,000
Regulated flow	1,498,000	2,497,000
Total:		
Natural flow	3,954,000	7,842,000
Regulated flow	4,795,000	7,977,000
Total in Washington:		
Natural flow	3,108,000	6,354,000
Regulated flow	3,846,000	6,568,000
Total in Oregon:		
Natural flow	846,000	1,488,000
Regulated flow	949,000	1,408,000

The immense water-power resources along Columbia River have attracted little interest until recently because of the lack of a market for large blocks of power. Development must be linked in some way with the establishment of industries to manufacture electrometallurgical products, fertilizers, chemicals and other articles requiring the use of large quantities of electrical energy. The electrification of the Northwestern railways would absorb only a small proportion of the available power. The industries could be operated within the vicinity of the power plants or at tide-water in Puget Sound and other north Pacific ports. The power is so located that it can be delivered economically to all of Washington, to most of Oregon and Idaho, and to the eastern part of Montana.

French Power Plant Swept Into River by Storm

Recently the power plant at La Picadere, on the L'One River below the Peyresourde Pass of the Pyrenees Mountains, was entirely wrecked by a storm of cyclonic fury which swept through France. The entire plant was swept into the river when the penstocks broke and two operators in the plant at the time were killed. There were nine deaths at Luchon, which was supplied with energy by the La Picadere plant, and the town's water system reservoir near the power plant was also swept away.

Hydro Project Proposed for Oporto, Portugal

The North Portugal Waterfall Co., whose head office is in Lisbon, has acquired several concessions for the development of hydro-electric power on the Cavado River and its affluent, the Rabagao, about 45 miles north of Oporto. The banking firm of Pinto & Sotto Mayor, the Portugese government, and a group of French financiers are interested. Energy will be distributed in northern Portugal, especially in the City of Oporto.

Work was begun on the first station in December, 1924, but only on a small scale. During the current year only preliminary work will be done, but it is hoped that by the summer of 1926 operations on a more extensive scale can be commenced. It is estimated that the completion of the undertaking will require more than five years. The chief problem will be raising the funds necessary to carry out the enterprise, according to the Commerce Department.

I. F. Baker, managing director of the Westinghouse Electric Co. of Japan, Francis Hodgkinson, chief engineer of the South Philadelphia Works of the Westinghouse Company, who is on a special engineering mission to Japan, and H. J. McManigal, railway engineer of the Westinghouse Electric of Japan, taken on a trip to the top of the Asama Volcano

Power-Generating Machinery Being Bought by Colombia

Shipments of power-generating machinery (omitting electrical equipment) increased approximately 12 per cent in 1923 over the preceding year. In 1924 a further gain of over 30 per cent occurred in this trade, the 1924 figure being $412,569, as against $320,016 for 1923. A greater demand for stationary steam engines, boilers, and internal-combustion engines was the leading factor in this increase.

An Increase of Personnel in Patent Office Recommended

The increase of the technical staff at the Patent Office by 100 is essential to placing the work there on a more satisfactory basis. A recommendation to that effect has been approved by the Committee on Patent Office Procedure.

An administrative assistant for the Commissioner of Patents is proposed, which will make it possible for the commissioner and assistant commissioner to devote their entire time to their judicial duties.

More attention to the classification division is urged. Thirty-five or forty additional examiners should be assigned to that work at once, the report says. Classification has been neglected because experienced examiners were not available. As a consequence there has been no revision of the classification of many of the arts for forty years.

The report shows that the present method of procedure is so involved and present equipment is so nearly obsolete that these drawbacks must be removed before improved conditions may be expected.

Water-Power Projects

Tennessee River Project—The Muscle Shoals Hydro-Electric Co. has applied to the Federal Power Commission for a license to construct a 54-ft. dam with power house immediately below, in the Tennessee River, in Lauderdale and Colbert Counties, Ala. The proposed installation will have a total primary capacity of 60,000 hp. and the power will be used for public-utility purposes.

Another Clearwater River Project—The Inland Power & Light Co. has applied to the Federal Power Commission for a preliminary permit covering a project on the Clearwater River in Nez Perce County, near Lewistown, Idaho. The dam is to be located two miles above Lewistown and power house is to be on Clearwater slough. This application conflicts with an application of the city of Lewistown, filed December 17, 1924.

Another Tennessee River Project—The Mississippi Power Co. has applied to the Federal Power Commission for a license to construct a dam and power house in the Tennessee River in Tishomingo Co., Miss., and Lauderdale County, Ala. The proposed installation will have a total primary capacity of 66,000 hp., and the power will be used for public-utility purposes.

Society Affairs

The American Oil Burner Association is the name officially adopted by the council of the association of oil burner manufacturers. The name was formerly American Association of Oil Burner Manufacturers.

The American Electrochemical Society will hold its fall meeting at the Signal Mountain Hotel, near Chattanooga, Tenn. As the meeting follows closely the completion of the Wilson Dam, an inspection trip to Muscle Shoals will be a part of the program.

Status of Adoption of A.S.M.E. Locomotive, Miniature, Unfired Pressure Vessel and Low Pressure Heating Boiler Codes by States and Cities

The American Uniform Boiler-Law Society, 253 Broadway, New York City, addressed the boiler inspection departments of the code states and cities, asking what action they has taken or contemplated taking, regarding the adoption or acceptance of the A.S.M.E. Locomotive, Miniature, Unfired Pressure Vessel and Low-Pressure Heating-boiler Codes, and their acceptance of boilers or vessels built in accordance therewith. From the replies received to date, we give the following information:

REPORT OF CODE STATES

	Will Accept Locomotive Boiler Code, Section 3*	Will Accept Miniature Boiler Code, Section 5*	Will Accept Un-Fired Pressure Vessel Code, Section 8*	Will Accept Low Pressure Heating Boiler Code, Section 4*
Rhode Island	Adopted.	Adopted.	Adopted.	Adopted.
New York	Yes†	Yes†	No jurisdiction	No jurisdiction
New Jersey	Adopted.	Adopted.	Recommended but not compulsory as yet	Recommended but not compulsory as yet.
Pennsylvania	Adopted.	Yes, if properly stamped	Yes, if properly stamped	Adopted.
Delaware	No jurisdiction as yet.	No jurisdiction as yet.	No jurisdiction as yet	No jurisdiction as yet.
Maryland§				
Michigan	No jurisdiction	Adopted.	No jurisdiction	Adopted.
Ohio	Yes, factor of safety of 5	Adopted.	No regulations as yet	Adopted without constructional changes.
Indiana	No action as yet	No action as yet	No action as yet	No action as yet.
Wisconsin	Yes	Yes	Yes	Yes.
Minnesota	Yes	Yes	Yes	Yes.
Missouri	Adopted.	Adopted.	No action	Adopted.
Washington§				
California	Yes	Yes	Being considered at the present time	Yes.
Oregon‡	Adopted.	Yes	Yes	Adopted.
Utah	Adopted.	Adopted.	Adopted.	Adopted.
Oklahoma	Adopted.	Adopted.	Adopted.	Adopted.
Arkansas	Yes	Yes	No jurisdiction	No jurisdiction.

*These sections, although issued in separate pamphlet form, are a part of the A.S.M.E. Boiler Construction Code.
†Provided same are properly stamped and manufacturers file data sheets with the department.
‡Boiler Inspection Department says: "We reserve the right to refuse to accept any miniature boiler or unfired pressure vessel which does not meet the requirements of the Boiler Construction Code."
§No reply as yet. Please communicate with us later for additional information.

REPORT OF CODE CITIES

Detroit, Mich	No jurisdiction	Adopted	Recommended for adoption	Adopted.
Erie, Pa.‡				
Kansas City, Mo.‡				
St. Louis, Mo	Will adopt	Will adopt	No action as yet	Will adopt.
St. Joseph, Mo.‡				
Philadelphia, Pa	No action as yet	No action as yet	No action as yet	No action as yet.
Los Angeles, Calif	Adopted.	Adopted.	Adopted.	Adopted.
Tampa, Fla	Yes	Yes	Yes	Yes.
Chicago, Ill.‡				
Nashville, Tenn	Yes	Yes	Yes	Yes.
Memphis, Tenn	Yes	Yes	Yes	Yes.
Scranton, Pa	Action the same as that taken by the Department of Labor and Industry, Harrisburg, Pa.			
Seattle, Wash	Yes	Yes	Yes	Yes.
Parkersburg, W. Va.‡				
Omaha, Neb	Yes	Yes	Yes	Yes.
Panama Canal Zone†	Yes.	Yes	Yes	Yes.
Territory of Hawaii	Yes	Yes	Yes	Yes.
District of Columbia‡				

*These sections, although issued in separate pamphlet form, are a part of the A.S.M.E. Boiler Construction Code.
†Where they do not conflict with rules of the Steamboat Inspection Service.
‡No reply as yet. Please communicate with us later for additional information.

Business Notes

The Kuhlman Electric Co., Bay City, Michigan, has appointed the Stevens Sales Co., 134 West Second South St., Salt Lake City, Utah, as district representatives for the State of Utah and parts of Idaho and Nevada, adjacent to Utah.

The Roller-Smith Co., 233 Broadway, New York City, manufacturer of electrical instruments and circuit breakers, announces the appointment of the Tennessee Engineering & Sales Co., 510 Burwell Bldg., Knoxville, Tenn., as its agent for the Knoxville district.

The Cornell Iron Works, Inc., manufacturer of commercial slat type, motor driven and underwriters' labeled rolling steel shutters and doors, announces the removal of its main office and factory to 71 Marion St., Long Island City. A branch office will be retained at 601 West 26th St., New York City.

Harlan W. Bird, merchant engineer, has opened an office in the Conway Bldg., Chicago, Ill. He will represent the M. A. Hofft Co., manufacturer of the "National" hand stoker and arch and the Tepco Stoker Co., builder of the Roach underfeed stoker.

The Armstrong Manufacturing Co., manufacturer of engines, boilers and shaking grates, Springfield, Ohio, announces the appointment of the Pitts & Kitts Manufacturing & Supply Co., 91 Seventh Ave., New York City, as its Eastern representative. This office is in charge of J. F. Arenholz.

The Bridgeport Brass Co., Bridgeport, Conn., announces that A. D. Merwin, formerly connected with the Steele & Johnson Manufacturing Co., Waterbury, Conn., has joined the organization as sales manager of the fabricating division, and that W. F. Blythe has been made sales manager of the mill-products division of the company.

Trade Catalogs

Soot Blowers — Marion Machine, Foundry & Supply Co., Marion, Ind. Bulletin No. 220 describes Types "E" and "EB" soot blowers for water-tube boilers.

Pumps, Centrifugal—Layne & Bowler Co., Memphis, Tenn. Bulletin describing the Layne centrifugal pump has just been issued and may be had by applying to the company.

Heating—The American Blower Co., 2539 Woodward Ave., Detroit, Mich. Pamphlet, "The Venturafin Method of Heating," describes the methods of heating any building by the company's system.

Air Heater—Combustion Engineering Corp., 43-47 Broad St., New York City. Catalog AH-2 describes fully the C-E air heater with charts showing operation and also photos of installations. The advantages of preheating air for combustion are taken up as well as the performance of this equipment.

Packing, Metal—The Garlock Packing Co., Palmyra, N. Y. Catalog A-A "Garlock Metal Packings That Are Mechanically Right," covers the various types of metal packing manufactured by the company. It is well illustrated and contains instructions for ordering the different types of metal packing.

Pumps, Centrifugal, Automatic—Barrett, Haentjens & Co., Hazelton, Pa. "The Automatic Operation of Centrifugal Pumps" is the title of a bulletin issued by the company describing methods used to make centrifugal pumps start, stop and run without constant attention. The bulletin is clearly illustrated.

Compressors and Pumps—Pennsylvania Pump & Compressor Co., Easton, Pa. Bulletin No. 123, recently issued, describes air compressors and vacuum pumps of straight-line, single-stage, double-acting types. The bulletin is illustrated and contains tables of sizes, capacities and ratings of the compressors and data on the vacuum pumps. It also contains tables of data on compressed air.

Coming Conventions

American Electric Railway Association. James W. Walsh, 8 West 40th St., New York City. Convention and exhibits at Young's Million Dollar Pier, Atlantic City, N. J., Oct. 5-9.

American Electrochemical Society. Dr. Colin G. Fink, Columbia University, New York City. Convention at Chattanooga, Tenn., Sept. 24-26.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Pacific Coast convention, Seattle, Wash., Sept. 15-17.

American Institute of Mining and Metallurgical Engineers. F. F. Sharpless, 29 West 39th St., New York City. Autumn Meeting at Salt Lake City, Aug. 31-Sept. 3.

American Society of Civil Engineers. George T. Seabury, 29 West 39th St., New York City. Fall meeting at Montreal, Oct. 14-16.

American Society of Mechanical Engineers—Calvin W. Rice, 29 West 39th St., New York City. Annual meeting at New York City, Nov. 30-Dec. 3.

American Society of Refrigerating Engineers, William H. Ross, 154 Nassau St., New York City. Annual meeting at New York City, Nov. 30-Dec. 3.

Association of Edison Illuminating Companies. Preston S. Miller, 80th St. and East End Ave., New York City. Annual meeting at New Arlington Hotel, Hot Springs, Ark., Oct. 19-23.

Association of Iron & Steel Electrical Engineers. John F. Kelly, Empire Bldg., Pittsburgh, Pa. Annual meeting at Philadelphia, Pa., Sept. 14-19.

Chemical Industries. Tenth Exposition at Grand Central Palace, New York City. Sept. 28-Oct. 3.

Electric Power Club. S. N. Clarkson, B. F. Keith Bldg., Cleveland, Ohio. Fall meeting at Briarcliff Manor, N. Y., Oct. 19-22.

Empire State Gas & Electric Association. C. H. B. Chapin, 5618 Grand Central Terminal Bldg., New York City. Meeting at Lake Placid Club, N. Y., Oct. 1 and 2.

Illuminating Engineering Society. Norman D. MacDonald, 29 West 39th St., New York City. Convention at Detroit, Mich., Sept. 14-18.

Iron and Steel Exposition. John F. Kelly, 706 Empire Bldg., Pittsburgh, Pa., Sept. 14-19. Exposition at the Philadelphia Commercial Museum, Philadelphia, Pa., Sept. 14-19.

National Association of Practical Refrigerating Engineers, Edward H. Fox, 5707 West Lake St., Chicago, Ill. Sixteenth annual convention and educational exhibition at Statler Hotel, Detroit, Mich., Dec. 8-12.

National Association of Stationary Engineers. F. W. Raven, 417 South Dearborn St., Chicago, Ill. National convention and exhibition at St. Paul, Minn., Aug. 31-Sept. 4. Annual conventions and exhibitions of state associations are scheduled as follows: **Minnesota Association** at St. Paul, Aug. 24-28. A. Nelson, 800 22nd Ave., Minneapolis, Minn.

National Exposition of Power & Mechanical Engineering. Fred W. Payne, Manager, Grand Central Palace, New York City. Exposition at Grand Central Palace, Nov. 30-Dec. 5.

National Safety Council. G. H. Cameron, 168 North Michigan Ave., Chicago, Ill. Fourteenth Annual Safety Congress at Cleveland, Ohio, Sept. 28-Oct. 2.

New England Water Works Association, Frank J. Gifford, Dedham, Mass., sec. Convention to be held aboard "Richelieu," en route Montreal to Quebec, etc., Sept. 8-11. For details apply to George E. Marsters, Inc., 248 Washington St., Boston, Mass.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; *mine run* except Pittsburgh gas slack:

Bituminous, Net Tons	Market Quoting	Aug. 10, 1925
Pool 1	New York	$2.35@$2.75
Smokeless	Boston	1.59
Clearfield	Boston	1.65@1.90
Somerset	Boston	1.75@2.00
Kanawha	Columbus	1.35@1.50
Hocking	Columbus	1.45@1.70
Pittsburgh	Pittsburgh	1.90@2.00
Pittsburgh gas slack	Pittsburgh	1.40@1.60
Franklin, Ill.	Chicago	2.25@2.50
Central, Ill.	Chicago	2.00@2.25
Ind. 4th Vein	Chicago	2.25@2.50
West Ky.	Louisville	1.10@1.25
S. E. Ky.	Louisville	1.35@1.75
Big Seam	Birmingham	1.50@2.00
Anthracite, Gross Tons		
Buckwheat No. 1.	New York	$2.15@$2.50
Buckwheat No. 1.	Philadelphia	2.50@2.75
Birdseye	New York	1.60

FUEL OIL

New York—Aug. 13, light oil, tank-car lots; 28@34 deg. Baumé, 5¼c. per gal., 36@40 deg., 5½c. per gal., f.o.b. Bayonne, N. J.

St. Louis — Aug. 6, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.85 per bbl.; 26@28 deg., $1.90 per bbl.; 28@30 deg., $1.95 per bbl.; 30@32 deg., $2.00 per bbl.; 32@36 deg., gas oil, 5c. per gal.; 38@40 deg., 5.6c. per gal.

Pittsburgh—Aug. 4, f.o.b. local refinery; 30@34 deg., fuel oil, 5¾c. per gal.; 36@40 deg., fuel oil, 6c. per gal.

Dallas—Aug. 8, f.o.b. local refinery, 26@30 deg., $1.40 per bbl.

Philadelphia — Aug. 6, 27@30 deg., $2.15@$2.21 per bbl.; 18@22 deg., $1.848@$1.908; 13@19 deg., $1.575@$1.635 per bbl.

Boston—Aug. 10, tank-car lots, f.o.b., heavy oil, 12@14 deg., Baumé, 4¼c. per gal.; light oil, 28@32 deg. Baumé, 5½c. per gal.

Cincinnati — Aug. 11, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5¼c. per gal.; 26@30 deg., 5⅝c. per gal.; 30@32 deg., 5⅝c. per gal.

Chicago — Aug. 11, tank-car lots, f.o.b. Chicago, 24@26 deg., $2.03 per bbl.; 30@34 deg., $2.23; 36@40 deg., 6c. per gal.

New Plant Construction

Ark., Lake Village—W. Kirten, Secy., is in the market for 50 to 65 hp. Diesel oil engine for waterworks system.

Ark., North Little Rock—The Standard Ice Co., plans the construction of a 50 ton ice plant.

Ark., Stuttgart—The Arkansas Light & Power Co., Pine Bluff, plans the construction of addition to ice plant here. Estimated cost $50,000.

Calif., San Diego—Kass & Ruben, Bank of Italy Bldg., Los Angeles, has had plans prepared for the construction of a 12 story office building at 3rd and C Sts., here. Estimated cost $1,500,000.

D. C., Washington—Bureau of Yards and Docks, Navy Department, will receive bids until August 26th for coal and ash handling machinery for Naval hospital.

Fla., Sebring—A. C. Lawrence, Mayor and City Council, will receive bids until September 4th for the construction of 2 sewage pumping stations, disposal plant, etc. Office of P. H. Norcross, 1404 Candler Bldg., Atlanta, Ga., Consult. Engrs.

Ga., Savannah—Savannah Electric Power Co., 27 West Bay St., plans to expend $400,000 for enlarging boiler capacity of main steam plant and general improvements.

Ill., Chicago — City awarded contracts for the construction of substructure and superstructure, etc., of a bridge over the Calumet River. Bids for electrical and operating houses will be advertised for later. Estimated cost $1,000,000. T. G. Pihlfeldt, is bridge engineer.

Ill., Chicago—Portland Cement Assn., 111 West Washington St., will soon award contract for the construction of a 5 story office building at North Dearborn St. and West Grand Ave. Estimated cost $500,000. Holabird & Roche, 104 South Michigan Ave., are architects.

Ill., Chicago—A. W. Swayne, 400 North Michigan Blvd., will receive bids until Aug. 25 for the construtcion of a 17 story apartment including 4 passenger and 4 freight elevators at 5830-5840 Stony Island Ave. Estimated cost $2,000,000. P. F. Olsen, 720 Cass St., is architect.

Ill., Fairfield—City voted $150,000 bonds for the construction of a waterworks system including pumping equipment, distribution mains, etc. G. Dunbar, Chemical Bldg., St. Louis, Mo., is engineer.

Kan., Lakin—C. H. Waterman, City Clk., will receive bids until August 20th for waterworks improvements including the construction of a well and pump house, one 125 g.p.m. motor driven centrifugal pump, one 125 g.p.m. gas engine driven centrifugal pump, one motor driven sump pump, one 250 g.p.m. motor driven deep well pump with auxiliary gasoline, one 125 g.p.m. two stroke pump, 50,000 gal. tank on tower, etc. E. T. Archer & Co., 612 New England Bldg., Kansas City, Mo., are engineers.

Mass., Boston—Union Institution for Savings, Tremont and Lagrange Sts., is having plans prepared for the construction of a 10 story bank and office building on Tremont St. Estimated cost $800,000. Thomas M. James Co., 3 Park St., is architect.

Mass., Northampton — Dept. Mental Diseases, W. A. Merrill, Business Agt., State House, Boston, will receive bids until August 19th for the construction of a heating and ventilating system at Northampton State Hospital, here. Estimated cost $25,000.

Mass., Wakefield—Neveroil Bearing Co., Foundry St., awarded contract for the construction of a factory and boiler house to W. T. Powers, 24 Union St., Sommerville. Estimated cost $40,000.

Mich., Grand Rapids — Grand Rapids Trust Building Co., is having plans prepared for the construction of a 13 story office building including steam heating system at Ionia & Monroe Aves. Estimated cost $1,500,000. Smith Hinchman & Grylls, 800 Marquette Bldg., Detroit, are architects.

Mich., Iron Mountain—Iron Mountain Hotel Corporation, c/o E. Bergendahl Co., 155 North Clark St., Chicago, Ill., Engrs., awarded contract for the construction of a 6 story hotel, theatre and business building to Worden-Allen Co., Port Washington Ave., Milwaukee, Wis. Estimated cost $650,000.

Miss., Gulfport—Edgewater Hotel Co., 5452 Broadway, Chicago, Ill., has acquired the Belmar Hotel site and plans the construction of a hotel midway between Biloxi and here. Estimated cost $2,000,000.

Mo., Joplin—Wilhoit Refinery Co., Villa Heights, plans improvements to plant including the installation of two 150 hp. boilers with heaters in power house. Estimated cost $150,000.

Mo., St. Louis—Hotel Jefferson Co., 12th and Locust Blvds., will receive bids about August 21st for the construction of a 13 story addition to hotel at Locust Blvd. and St. Charles St. Estimated cost $1,500,000. T. P. Barnett & Co., Arcade Bldg., are architects.

Mo., St. Louis—Wagner-Grant-Bell Realty Co., International Life Bldg., is having preliminary plans prepared for the construction of a 10 story apartment at Skinker and Rosebury Sts. Estimated cost $750,000. Private plans.

Mo., Springfield—The Merchants Ice Co., R. F. McVay, Mgr., 1017 South Pickwick St., plans the construction of 6 ice stations including refrigerating machines 6 to 10 ton capacity each.

Neb., Grand Island—City is having plans prepared for waterworks improvements including the construction of a reservoir, power plant, pumping equipment, etc. Estimated cost $300,000.

Neb., Lincoln—Lancaster Hotel Co., plans the construction of an 11 story hotel. Estimated cost $1,500,000. George B. Post & Son, 1003 Pioneer Trust Bldg., is architect.

Neb., Spencer—Northern Nebraska Power Co., plans the construction of a hydro-electric power plant including a dam on the Niobrara River which will furnish power for 24 towns in Nebraska and South Dakota. Estimated cost $500,000.

N. Y., New York—Estate of E. A. Hoffman, Inc., 258 Broadway, is having plans prepared for the construction of an 8 story addition to office building at 6th Ave. and 42nd St. Estimated cost $1,000,000. York & Sawyer, 100 East 42nd St., are architects and engineers.

N. Y., New York—Lincoln Hospital, 141st St. and Concord Ave., is having plans prepared for alterations and additions to nurses' home on Concord Ave. Estimated cost $1,000,000. Harrett & Van Vleck, 393 7th Ave., are architects and engineers.

N. Y., New York—New York State Bridge and Tunnel Comn. and New Jersey Interstate Bridge and Tunnel Comn., 3004 Woolworth Bldg., will receive bids until September 8th, for the installation of 84 ventilating fans, 6 transformer blower fans and 90 motors.

N. Y., New York—One Hundred and Fifty, William St. Corporation, c/o Starrett & Van Vleck, 393 7th Ave., Archts., is having plans prepared for the construction of a 19 story office building on William St. Estimated cost $2,750,000.

N. C., Hendersonville—J. P. Stoltz, Miami, Fla., plans the construction of a 15 story hotel here. Estimated cost $1,000,000. Architect not announced.

N. C., Raleigh—City Commissioners passed an ordinance providing for the issue of $250,000 bonds for improvements to waterworks system including a new electrical centrifugal pump, additional mains, etc. C. C. Page is commissioner of public works.

O., Athens—Dept. of Public Welfare, J. E. Harper, Dir., 9th and Oak Sts., Columbus, is in the market for a 250 hp. Heine boiler and stoker for State hospital at Athens.

O., Cleveland—Bd. of County Comrs., L. Simon, Clk., Court House, will receive bids until August 26th for 1 vacuum pump.

O., Dilles—Ohio Power Service Co., T. O. Kennedy, Pres., 1800 B. F. Keith Bldg., Cleveland, plans the construction of a steam electric power plant. Initial capacity 100,000 hp., ultimate 500,000 hp. Estimated cost $2,000,000. G. E. Snider, 1800 B. F. Keith Bldg., Cleveland, is engineer.

O., Nelsonville—Hall Bros., J. A. Hall, Pur. Agt., is in the market for coal mining equipment including three 25 hp. motors for Black Diamond mine.

Okla., Chickasha—City is having preliminary plans prepared for improvements to waterworks system including pumping equipment, mains, etc. R. O. Bradley is engineer.

Okla., Fort Cobb—J. M. Swigart is having preliminary plans prepared for the construction of a 17-ton capacity raw water ice plant. Estimated cost $30,000. Private plans. Owner is in the market for a 50 hp. oil engine and raw water ice plant equipment.

Okla., Hinton — City plans an election August 28th to vote $25,000 bonds for a new oil engine electric light plant and extension to distribution system. Benham Engineering Co., 512 Gumbel Bldg., Kansas City, Mo., is engineer.

Okla., Muskogee—City plans an election August 21st to vote $225,000 bonds for the construction of a new filter plant including motor driven pumps, pumping equipment, etc. Burns & McDonnell Engineering Co., 602 Interstate Bldg., Kansas City, Mo., are engineers.

Ore., Portland—Corbett Estate, awarded contract for the construction of a 12 story office building at Yamhill, 5th and 6th Sts. to Hansen, Hammond & Clist, Pittock Block. Estimated cost $1,000,000.

Ore., St. Helens—Hawley Pulp & Paper Co., W. P. Hawley, Pres., Oregon City, plans the construction of a paper mill on the Columbia River here. Estimated cost $1,000,000. Engineer and architect not selected. Owner is in the market for all machinery, including boilers, engines, etc.

Pa., Kennett Square—Council Chamber, W. E. Voorhees, Secy., will receive bids until August 24th for 2 centrifugal pumps, motors and electric control equipment for waterworks pumping station.

Pa., Philadelphia—Dept. of Public Health, W. Krusen, Director, City Hall, awarded contract for the construction of a group of hospital buildings to F. W. Mark Construction Co., Commercial Trust Bldg., $2,693,095.

Pa., Philadelphia—General Electric Co., Witherspoon Bldg., plans the construction of building No. 10 at 68th and Elmwood Sts. Harris & Richards, Drexel Bldg., are architects.

Pa., Pittsburgh—J. M. Donn, 1219 Connecticut Ave., Washington, D. C., awarded contract for the construction of a 9 story apartment on Ellsworth Ave., here to Boyle Robertson Construction Co., 16th and Harvard Sts. N.W., Washington, D. C. Estimated cost $1,000,000.

Pa., Washington—Washington Hospital, A. Donnan, chn. Building Committee, awarded contract for the construction of a 4 story hospital to Hutter Construction Co., 128 Western Ave., Fond du Lac, Wis. Estimated cost $650,000.

Tex., Sinton—J. W. Benson & Son plan the construction of a cold storage plant. Estimated cost $18,000. Private plans.

Wash., Seattle—F. Fowler, L. C. Smith Bldg., Archt., will soon receive bids for the construction of a 9 story hotel at 3rd and Blanchard Sts. for C. C. Cornelius. Estimated cost $750,000.

Wis., Menasha—J. De Caro, Clk., will receive bids until September 1st for a 600 to 1,000 hp. Diesel engine and motor generator for the water and light plant.

Wis., Racine—Racine Horse Shoe Tire Co., 1215 State St., is having preliminary plans prepared for the installation of additional boilers in plant. Cahill & Douglas, 217 West Water St., Milwaukee, are engineers.

Wis., Racine—H. W. Voelz, 373 Broadway, Milwaukee, Archt., will soon receive bids for the construction of a dairy plant for Progressive Dairy Co., 1214 Lathrop Ave. Estimated cost $60,000. Owner is in the market for refrigeration machinery.

N. B., Loggienele—A. & R. Loggie Co., Ltd., is in the market for a 300 hp. engine.

Ont., Township of York—Township of York, Warren and Bayview Aves., plans the construction of a sewage pumping station including an electric driven pump. Estimated cost $75,000. James, Proctor & Redfern, 36 Toronto St., Toronto, are consulting engineers.